RISK FACTORS FOR WORK-RELATED ASTHMA IN HEALTH WORKERS WITH EXPOSURE TO DIVERSE CLEANING AGENTS IN TWO AFRICAN HEALTH CARE SETTINGS

By

Dr Hussein Hassan Mwanga

Thesis presented for the degree of

Doctor of Philosophy

in the School of Public Health and Family Medicine

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Supervisor: Professor Mohamed Fareed Jeebhay

Co-supervisor: Dr Roslynn Baatjies

This thesis is presented in fulfilment of the requirements for the degree of Doctor of Philosophy (PhD) in the School of Public Health and Family Medicine, Faculty of Health Sciences, University of Cape Town. The work on which this thesis is based is original research and has not, in whole or in part, been submitted for another degree at this or any other university. The contents of this thesis are entirely the work of the candidate.

Signed by candidate

Dr Hussein Hassan Mwanga

17 September 2019

ABSTRACT

Background: Health workers (HWs) are exposed to a wide range of chemicals used for cleaning and disinfection. This has been largely attributed to the ever-increasing demand for effective cleaning and disinfection in hospital settings in an effort to prevent healthcare associated infections. Over the last two decades, there has been increasing evidence linking cleaning agents to adverse work-related health effects such as rhinitis, asthma and contact dermatitis. There is however little information on the specific cleaning agents and tasks associated with various asthma-related outcomes. Furthermore, limited information exists regarding exposure-response relationships between the frequency of exposure to specific cleaning agents and asthma-related outcomes. This study investigated the prevalence and risk factors for work-related asthma (WRA) among HWs exposed to diverse cleaning agents in two academic tertiary public hospitals in southern Africa - South Africa and Tanzania.

Methods: A cross-sectional study of 699 HWs was conducted. Exposure assessment included systematic workplace observations, environmental sampling for aldehydes (ortho-phthalaldehyde-OPA, glutaraldehyde and formaldehyde) and urine biomonitoring for chlorhexidine. Environmental sampling for aldehydes was conducted more extensively in the South African hospital (SAH). A pilot sampling in the Tanzanian hospital (TAH) revealed very low detectable levels of OPA and glutaraldehyde and as a result extensive measurements were not done. In the SAH, a total of 269 full-shift passive personal samples were collected from 164 HWs randomly selected from 17 different clinical departments. Passive sampling used TraceAir® AT580 monitors (Assay Technology, Livermore, CA). Biomonitoring for chlorhexidine was only conducted in the SAH since none of the HWs in the TAH used chlorhexidine. For the health outcome assessment, a total of 697 HWs completed interviews using the ECRHS questionnaire adapted for occupational contexts, which contained in-depth information on asthma, as well as detailed information on tasks and chemicals used during the course of their work. Sera was successfully collected from 682 HWs and analysed for specific immunoglobulin E (sIgE) antibody reactivity to common aero-allergens (Phadiatop) and specific occupational allergens (NRL - *Hevea brasiliensis* (Hev b5, Hev b6.02), chlorhexidine and OPA). Methacholine challenge tests (MCT) were performed on all South African HWs (n=318), based on standard inclusion criteria. Spirometry, accompanied by a post-bronchodilator (post-BD) test was conducted on all Tanzanian HWs (n=329) and a small proportion (n=25) of South African HWs where MCT was contraindicated. All HWs from both hospitals (n=654) underwent fractional exhaled nitric oxide (FeNO) testing during the working day prior to spirometry.

Results: The prevalence of current asthma was 10% (atopic asthma 6%, non-atopic asthma 4%), while 2% had WRA. The prevalence of atopy was 43%, with 4% of workers being sensitised to OPA, 2% to NRL and only 1% to chlorhexidine. Environmental sampling demonstrated that OPA was detectable in 6 (2%) samples, all samples (Geometric mean (GM) = 0.010 ppm) being higher than the ACGIH exposure limit (0.0001 ppm). Workers with detectable OPA were found to have a longer duration of OPA use (OR = 1.28; 95% CI: 1.10 – 1.50). Formaldehyde was detectable in 103 (38%) samples (GM = 0.005 ppm), with 1% of samples having levels higher than the NIOSH TWA exposure limit (0.016 ppm). Asthma-related outcomes (increasing asthma symptom score and FeNO) demonstrated consistent positive associations with certain medical instrument cleaning agents (OPA, QACs and enzymatic cleaners) and tasks (pre-cleaning of medical instruments, changing sterilisation solutions and manual disinfection of medical instruments) as well as certain patient care activities (disinfection prior to procedures, cleaning/disinfecting wounds, application of wound dressing, usage of adhesives and adhesive removing solvents). A particularly pronounced dose-response relationship was observed between work-related ocular-nasal symptoms and medical instrument cleaning agents (OPA, glutaraldehdye, QACs, enzymatic cleaners, alcohols and bleach; OR range: 2.50 – 12.08) and tasks (OR range: 2.58 – 3.97). Furthermore, a strong association was observed between higher asthma symptom scores and use of more sprays than wipes for fixed surface cleaning activities (mean ratio = 3.00; 95% CI: 1.50 – 5.98).

Conclusion: This study has demonstrated that detectable exposures to OPA are higher and more isolated to certain departments than the more widespread low-level formaldehyde exposures present throughout the hospitals. Furthermore, cleaning agents have replaced NRL as important causes for WRA in health settings. Finally, specific cleaning agents such as OPA, quaternary ammonium compounds and enzymatic cleaners associated with medical instrument cleaning/disinfection as well as patient care activities and the use of sprays for fixed surface cleaning, are important environmental risk factors for various asthma-related outcomes among HWs in health care settings.

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PREFACE

The following scientific paper was published during the doctoral research period:

- **Mwanga H.H.**, Jeebhay MF. Work-related asthma associated with cleaning agents in the health care setting – A Review. South African Respiratory Journal. 19(4);121-7, 2013 (Appendix I)

Some of the study findings have been presented at various scientific meetings including national and international conferences. These are listed below:

- **Mwanga H.H.,** Baatjies R., Jeebhay M.F**.** Exposure to aldehydes among health care workers in a large tertiary hospital in Cape Town, South Africa. 32nd ICOH Congress, Dublin, Ireland, April 2018.
- **Mwanga H.H.**, Baatjies R, Singh T, Jeebhay M.F. Risk factors for work-related asthma in health care workers with exposure to diverse cleaning agents. Public Health Association of South Africa Conference, East London, Sept 2016.
- **Mwanga H.H.**, Baatjies R, Singh T, Jeebhay M.F. Changing patterns of occupational allergy and asthma among health care workers in South Africa. Allergy Society of South Africa, ALLSA Journal Club on occupational allergy, Cape Town, Sept 2016.
- **Mwanga H.H.,** Baatjies R., Singh T., Jeebhay M.F**.** Risk factors for work-related asthma in health care workers with exposure to diverse cleaning agents. Congress of the European Academy of Allergy and Clinical Immunology, Vienna, Austria, June 2016.

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LIST OF ABBREVIATIONS

ACGIH: American Conference of Governmental Industrial Hygienists
BDR: bronchodilator response
BHR: Bronchial hyper-responsiveness
BMI: body mass index
CI: confidence interval
CIR: continuous index of responsiveness
DNPH: 2,4-dinitrophenylhydrazine
DRS: dose-response slope
ECRHS: European Community Respiratory Health Survey
ELISA: enzyme-linked immunosorbent assay
FeNO: fractional exhaled nitric oxide
FEV_1: forced expiratory volume in one second
FVC: Forced vital capacity
GM: geometric mean
GTA: glutaraldehyde
Hev b: *Hevea brasiliensis*
HMW: high molecular weight
HPLC: high-performance liquid chromatography
HWs: health workers
IgE: immunoglobulin E
IL: interleukin
IPC: infection prevention and control
JEM: job exposure matrix
LEV: local exhaust ventilation
LMW: low molecular weight
LOD: limit of detection

MCT: methacholine challenge test
MR: mean ratio
NIOSH: National Institute for Occupational Safety and Health
NSBH: nonspecific bronchial hyperresponsiveness
NRL: natural rubber latex
OA: occupational asthma
OHS: occupational health and safety
OPA: ortho-phthalaldehyde
OR: odds ratio
Post-BD: post-bronchodilator
ppb: parts per billion
PPE: personal protective equipment
ppm: parts per million
QAC: quaternary ammonium compounds
RADS: reactive airways dysfunction syndrome
SAH: South African hospital
SAHWs: South African health workers
SDS: safety data sheets
sIgE: specific immunoglobulin E
SPT: skin prick test
TAH: Tanzanian hospital
TAHWs: Tanzanian health workers
Th2: T helper cells 2
TWA: time-weighted average
US: United States of America
WEA: work-exacerbated asthma
WRA: work-related asthma
WRAS: work-related asthma symptoms
WRONS: work-related ocular-nasal symptoms
WRSS: work-related skin symptoms

CHAPTER 1

INTRODUCTION

1.1. INTRODUCTION

Work-related asthma (WRA) is commonly classified as occupational asthma (OA), caused by a particular workplace agent or work-exacerbated asthma (WEA), which is a preexisting asthma worsened by workplace agents (1). Previous studies have shown that the proportion of adult-onset asthma attributable to occupational exposure is between 10-15% of the population (2). Studies in the past decade (1,3,4) indicate that the population-attributable risk of 10-25% for adult asthma related to occupation exceeds that of previously reported studies. More recently, in a British postal survey among adults with asthma, 33% reported work-aggravation of their asthma symptoms (5). Furthermore, studies have shown that occupational asthma is under-recognised in clinical practice (1,6). Occupational exposure as a cause of adult onset asthma may therefore be more common than is appreciated. In the South African setting, a population attributable fraction of 13% has previously been estimated (7) with occupational asthma ranked as the second most common occupational lung disease after the pneumoconioses (8).

Health workers (HWs) are among the high risk occupational groups for developing WRA, and accounting for 16% of WRA patients in a US surveillance study (9). It is well known that natural rubber latex (NRL) has historically been a common cause of WRA in HWs (10–13). However, studies in the past decade have reported a decrease in NRL allergy among HWs due to substitution with less allergenic alternatives or a reduction in powder and protein content of gloves with the incidence of sensitisation to NRL allergens having decreased to 1% in countries that have promoted latex avoidance (10,14–17). Nevertheless, powdered NRL gloves continue to be widely used in developing countries due to economic reasons, posing an increased risk for allergic sensitisation and asthma.

With the global decline in the incidence of NRL allergic asthma, cleaning agents have increasingly been considered a major risk factor for WRA in the health care setting (17–19). Cleaning agents have been shown to cause work-related asthma-like symptoms, new onset asthma with or without latency and may also exacerbate asthma symptoms in asthmatic individuals (20,21). It is estimated that 12% of WRA is related to the use of cleaning products among patients reported in a US surveillance registry (22). Furthermore, among the causes of work-related reactive airways dysfunction syndrome (RADS), cleaning agents constituted the largest group (15% of the cases) reported by the same surveillance program for WRA (23).

In recent years, there has been an increasing demand for effective cleaning and disinfection in hospital settings in order to prevent healthcare associated infections, particularly those caused by the multi-drug resistant organisms (24). These efforts have resulted in strict infection prevention guidelines requiring extensive use of various types of cleaning agents in hospital settings (25). As a result, HWs are exposed to higher concentrations of a wider range of cleaning agents, some known to be potent respiratory sensitisers and irritants.

Most cleaning agents are irritants but some have sensitising properties as well (20). Major groupings of potential sensitisers and irritants that are present in health care settings include medical instrument cleaning and disinfecting products (e.g. glutaraldehyde and ortho-phthalaldehyde - OPA); fixed surface cleaning products (e.g. bleach); floor finishing products (stripping, waxing & buffing e.g. ethanolamine); specimen preparation products (e.g. formaldehyde); patients' skin / wound cleaning & disinfecting products (e.g. chlorhexidine and povidone iodine) and hand washing / sanitising products (e.g. chlorhexidine and alcohols). Other potential sensitisers and irritants in health care settings include NRL, aerosolised medications (e.g. pentamidine), methacrylates in dental and surgical cements, micro-organisms and mildew (20,25,26). While previous studies have reported on the association between respiratory symptoms or asthma and these broad categories of cleaning-related exposures in health care settings (20,21,27,28), only a few epidemiological studies and case reports have identified specific cleaning agents associated with these outcomes (29–31).

Little is known about the magnitude of asthma burden among HWs in South Africa. A few studies among HWs in South Africa have focused mainly on NRL and exposures such as endotoxins, but none on cleaning agents (32–37). The South African study of dental HWs (37) reported a 6.9% prevalence of atopic asthma and a slightly lower proportion (5.9%) with non-atopic asthma. In this occupational group, WEA was reported in 4% of the study population. On the other hand, the prevalence of asthma specifically among HWs in Tanzania is unknown.

Exposure assessment for cleaning agents has historically been a challenge since various cleaning agents with different ingredients are used simultaneously, resulting in airborne exposures that are usually a complex mixture of various chemicals with different physico-chemical properties that require multiple sampling techniques (38). Furthermore, the type of product used, the frequency and duration of its use, varies depending on the specific cleaning task performed (25,38). Frequently, several cleaning tasks are performed in an isolated room and may be repeated several times a day. Furthermore, various HWs may use the same cleaning agent in different ways resulting in variable degrees of exposure. As a result only a few studies have been reported on quantitative exposure assessment for cleaning agents in general, and aldehydes such as glutaraldehyde and OPA in particular.

This study was prompted by the increasing number of HWs with WRA and skin complaints presenting to the Occupational Medicine clinic at Groote Schuur Hospital. The study was conducted to determine the contribution of cleaning agents towards the development of WRA among HWs in two southern African health care settings, South Africa and Tanzania, since little recent information was available with regard to the magnitude of asthma among HWs and specifically, the contribution of cleaning agents in relation to WRA among HWs. Furthermore, while some studies in other parts of the world, had reported on quantitative exposure assessment for cleaning agents, none had been reported from southern Africa. Moreover, little information exists on the specific cleaning agents and tasks associated with various asthma phenotypes and limited evidence regarding specific dose-response relationships. It was also important to determine the residual contribution of NRL to WRA following a reduction in latex glove usage practices in the South African Hospital. Furthermore, there was also a need to better understand the association between WRA and host-related risk factors that could modify these risks in exposed workers. It was envisaged that the specific information obtained from this study would contribute towards the development of appropriate preventive strategies for WRA associated with exposure to cleaning agents in the health care settings in general and the African setting in particular.

1.2. STUDY AIM

To determine prevalence and risk factors for work-related asthma among health workers in a South African and Tanzanian tertiary academic public hospital with widespread use of cleaning agents.

1.3. OBJECTIVES

1) To characterise the exposure of health workers to major categories of cleaning agents (e.g. medical instrument cleaning/disinfection and fixed surfaces cleaning) in relation to specific chemicals used, frequency and duration of use, job type, specific tasks and protective measures in place.
2) To characterise predominantly dermal exposure to chlorhexidine-containing cleaning products through determination of urinary levels of chlorhexidine and its metabolites.
3) To characterise inhalational exposure to OPA (a high-level disinfectant used for medical instruments) through personal environmental sampling and investigate the determinants of exposure variability (e.g. jobs, tasks) in this health care setting.
4) To determine the prevalence of work-related respiratory and skin symptoms, allergic sensitisation and lung function abnormalities in health workers of these two hospitals.

5) To describe various asthma phenotypes (non-work-related and work-related) based on the presence of respiratory symptoms, allergic sensitisation, airway obstruction, nonspecific bronchial hyperresponsiveness and airway inflammation, and determine their association with host risk factors.
6) To determine the association between various asthma-related outcomes (general and work-related) and environmental risk factors, controlling for potential confounders.

1.4. STRUCTURE OF THE THESIS

Chapter 2 is a comprehensive literature review focussing on the relationship between exposure to cleaning agents and asthma-related outcomes in health care settings. The chapter includes information on the working populations at risk of developing adverse health effects due to cleaning agents, exposure characterisation for cleaning agents, epidemiology of asthma related to cleaning agents, pathophysiological mechanisms of asthma related to cleaning agents, workplace environmental risk factors and causative agents, host-associated risk factors and preventive strategies for WRA associated with cleaning agents in the health care settings.

Chapter 3 gives a detailed description of the methods used for this study. The chapter describes the study design, population and sampling strategy, the various exposure assessment strategies employed and a detailed description of the various methods used for the health outcome assessment of the epidemiological study.

Chapter 4 describes the detailed characterisation of health workers' exposure to cleaning agents in the two hospitals. It includes information on the systematic workplace observations that were conducted, environmental sampling for aldehydes (OPA, glutaraldehyde and formaldehyde) and biomonitoring for chlorhexidine. It also investigates the determinants of exposure variability, especially for the measured aldehyde levels, in order to identify specific risk factors that could be targeted for prevention.

Chapter 5 describes the prevalence of work-related respiratory and skin symptoms, allergic sensitisation profiles and various lung function indices used to identify airway obstruction, non-specific bronchial hyperresponsiveness and airway inflammation among health workers in the two hospitals.

Chapter 6 describes the various asthma phenotypes identified among this group of health workers and provides a detailed exploration of their relationship with host-associated risk factors.

Chapter 7 provides a detailed description of the environmental risk factors (specific cleaning agents and tasks) including exposure-response relationships for the association between the various asthma-related outcomes among these health workers.

Chapter summarises the most important findings of this study. Strengths and limitations of the study are discussed and practical preventive strategies for reducing the burden of work-related asthma related to cleaning agents in heath care settings are presented.

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CHAPTER 2

LITERATURE REVIEW

2.1. Background

Various studies have demonstrated that health workers (HWs) are at increased risk of developing work-related asthma due to their exposure to various agents that are respiratory sensitisers or irritants such as cleaning agents, natural rubber latex (NRL), diisocyanates, methacrylates, medications and mildew (1–4). Exposure to cleaning agents has become of particular importance in health care settings due to the extensive use of various types of cleaning chemicals so as to comply with strict infection prevention standards that have been implemented to prevent healthcare associated infections (3,5). In the past two decades, an increasing number of case reports, epidemiological and surveillance studies have reported an increased risk of asthma, rhinitis and contact dermatitis associated with cleaning-related exposures in health care settings (3,5–8). However, only a limited number of studies have investigated the specific cleaning agents associated with work-related asthma in HWs.

Search strategy

Several electronic literature sources were searched including PubMed, Google Scholar and Embase for relevant articles using various key words: allergy, asthma, occupational asthma, work-related asthma, cleaning agents, cleaning products, disinfectants, sterilants, chlorhexidine, ortho-phthalaldehyde, glutaraldehyde. Reference lists from the articles obtained were also screened for relevant publications. Selection of articles to be included in the review was not restricted to any time period. However, epidemiological studies that investigated work-related asthma associated with cleaning agents in the health care setting during the last 15 years (2004 to 2019) were summarised in Table 2.1.

2.2. Working populations at risk

Based on occupations in the health care sector, workers considered to be potentially at increased risk include nurses, cleaners, physicians, respiratory therapists and occupational therapists (9–12). Nursing professions typically consist of a number of sub-groups, such as registered nurses, licensed practical nurses, licensed vocational nurses, nurse aides, nurse practitioners and nurse trainers (12). Arif *et al* (12) demonstrated that among nurses, registered nurses had the highest prevalence of reported asthma (10.2%), followed by licensed vocational nurses (8%) and nurse practitioners and nurse aides (6.9%). The reason/s for difference in the prevalence of reported asthma among these groups of nurses in this study (12) was not explained by the authors and perhaps not well understood at the time.

Other studies have also demonstrated that cleaners in hospitals also have a higher odds (odds ratio (OR) = 2.1; 95% CI: 1.1 to 4.2) of having current asthma when compared to those who have never done a cleaning job or those cleaners that had not worked in any listed high risk workplaces (industries, hospitals, kitchens, laboratories, schools, outdoors, private homes, common areas in apartment buildings, other healthcare settings), most likely due to their increased likelihood of exposure to irritant cleaning products (13).

2.3. Exposure characterisation for cleaning agents

Exposure assessment for cleaning agents has been challenging partly due to the fact that many cleaning agents having different ingredients are used simultaneously in the health care setting. Airborne exposures generated in these settings are commonly a complex mixture of various chemicals with different physicochemical properties requiring different sampling techniques (14,15). Another challenge is that the type of product used, its frequency and duration of use usually varies depending on the specific cleaning task performed (14,16). Commonly, several cleaning tasks are performed in a single room and may be repeated several times a day. Furthermore, HWs may use cleaning agents differently, resulting in varying amounts of chemical exposures for a single category of HWs. As a result, very few studies have conducted quantitative exposure assessments for cleaning agents in the health care setting. In a case-control study among Spanish domestic cleaners, quantitative exposure assessment for chlorine and ammonia was conducted in a sub-group of 10 participants (17). In this study, airborne exposure levels of both chlorine (median: 0–0.4 ppm) and ammonia (median: 0.6–6.4 ppm) were detectable during domestic cleaning using cleaning products containing bleach and ammonia.

There is limited information regarding assessment of environmental exposure to aldehydes such as glutaraldehyde (GTA) and ortho-phthalaldehyde (OPA). In a study of various endoscopy units in an Italian hospital (18), detectable GTA levels (mean = 0.005 ppm) were slightly higher than in the US study (19) of HWs from eight health care facilities (range: not detected – 0.005 ppm). However, much higher GTA levels (geometric mean (GM) = 0.025 ppm) were reported in a Canadian study of five hospitals (20).

A literature search revealed few studies that have conducted measurement of OPA exposure in air (19,21–26). The mean OPA concentration reported in a previous Italian study among HWs in endoscopy units was 0.0015 ppm (18). A Japanese study that conducted air measurements for OPA in an endoscopy unit reported OPA concentrations in the range of 0.0006 – 0.002 ppm (27). The highest concentration (0.002 ppm) was found when a bucket containing OPA was left open without a lid while an endoscope washing machine was operating (27). A later Japanese study conducted air measurements for OPA in 9 manual disinfection rooms and in 8 rooms using automatic endoscope washers (24). The TWA concentration of OPA in this Japanese study was higher in the manual group (median = 0.0007 ppm) than in the automatic endoscopic washer group (median = 0.0003 ppm) (24). In the US study, the average OPA concentrations were higher (GM = 0.00006 ppm) in the group of workers from the departments using OPA than in the comparison group (GM = 0.00003 ppm) where OPA was not used (19).

Literature on the development of sampling and analytical methods for the determination of airborne OPA concentrations is even more scant. A study by Uchiyama *et al.* published a method for the determination of OPA in air using 2,4-dinitrophenylhydrazine (DNPH)-impregnated silica cartridges and high-performance liquid chromatography (HPLC) (22). Subsequently, Tucker reported a method for determining OPA concentration in air and two methods for measuring OPA exposure on surfaces (23). A more recent study by Tucker reported two partially validated methods for determination of OPA in air, one (DNPH-HPLC method) being an improvement of his previous method (26).

Despite the presence of commercially available passive samplers, a literature search did not find any study that has measured OPA in the air using the passive method. However, studies on passive sampling for formaldehyde and GTA have been reported (28,29). Previous studies comparing the performance of passive and active sampling methods for formaldehyde have shown good agreement between the two assessment methods (28). However, a recent study demonstrated that passive sampling generally overestimated the formaldehyde concentrations when compared to the active method (30). In this study, the median formaldehyde concentration reported ranged from 0.04 ppm using the active method to 0.05 ppm for the passive method. Passive samplers are sometimes preferred over active ones for several reasons in that they are convenient since they are small and lightweight; can be used by most people with minimal training; are less expensive; and often do not interfere with the usual workers' routine (30).

Chlorhexidine is one of the most commonly used agents for hand hygiene and patient care activities such as disinfection of wounds and patients' skin prior to various medical procedures (31). The most appropriate method of estimating exposure to chlorhexidine is to conduct biological exposure monitoring. Environmental air sampling is considered inappropriate since chlorhexidine has a low likelihood of being aerosolised given its very lower vapour pressure. Again, few studies have conducted chlorhexidine biomonitoring (32). Some of these researchers have been able to identify chlorhexidine and its metabolites (*p*-chloroaniline and 1-chloro-4-nitrobenzene) in biological fluids but challenges have arisen in quantifying the concentration of these chemicals (32–34) .

2.4. Epidemiology of asthma related to cleaning agents

Few epidemiological studies have investigated the magnitude of asthma among HWs exposed to various cleaning agents (**Table 2.1**). In an international prospective population-based study [European Community Respiratory Health Survey-II (ECRHS-II)], the prevalence of new-onset asthma (asthma attack or taking asthma medication in the past 12 months) among nurses was found to be 4.8% (35). A more detailed analysis of HWs from this study (36) reported a slightly higher prevalence (6%) of new-onset asthma (currently taking asthma medication, asthma attack or woken up by an attack of shortness of breath in last 12 months), most likely due to different asthma definitions used. These findings are similar to the that of a US study among HWs (n=3650) with active professional licenses (1), which demonstrated an overall prevalence of doctor-diagnosed asthma with onset after entry into the healthcare profession to be 6.6%. The highest prevalence was observed among nurses (7.3%) followed by respiratory therapists (5.6%), occupational therapists (4.5%) and doctors (4.2%). However, a study published 2 years later of the same US population of HWs reported a much higher prevalence of diagnosed asthma with onset after entry into the healthcare profession (9.8%) among nurses based on the longest job held (12). Overall, the prevalence of asthma in HWs exposed to cleaning agents has ranged between 4.4% and 11.2% (current asthma: 4.8% – 11%; doctor-diagnosed asthma: 9 – 11.2% and doctor-diagnosed asthma with onset after entry into the healthcare profession: 4.4% – 9.8%) (1,12,13,35–37). Little is known about the magnitude of asthma in HWs in South Africa. However, in a recent South African study among dental HWs (38), the prevalence of atopic asthma was 6.9%, non-atopic asthma 5.9% and work-exacerbated asthma 4%. On the other hand, the prevalence of asthma among Tanzanian HWs is unknown.

Table 2.1: Recent epidemiological studies on work-related asthma associated with cleaning agents in the health care setting

Author/ year	Population (n)	Prevalence of asthma phenotypes / symptoms	High risk activities significantly associated with asthma OR / RR (95% CI)	Cleaning agents significantly associated with asthma OR/RR / MR (95% CI)	Tools used for assessment of exposure and asthma-related outcomes
Dumas *et al*, 2018 (31)	Nurses (n = 4055)	Prevalence not specified. Asthma control was defined by Asthma Control Test (ACT)	Surgical hand/arm hygiene: ≥1 time/day: 1.96(1.52-2.51); <1 time/day: 1.38(1.06-1.80)	Not specified	Questionnaire
Dumas *et al*, 2017 (39)	Nurses (n = 4102)	Prevalence not specified. Asthma control was defined by Asthma Control Test (ACT)	Use of disinfectants for medical instruments: 1.88 (1.38-2.56)	Formaldehyde: 1.33 (1.05-1.68) Enzymatic cleaners: 1.33 (1.12-1.57) Hydrogen peroxide: 1.19 (1.04-1.36) Glutaraldehyde: 1.18 (1.03-1.34) Hypochlorite bleach: 1.18 (1.03-1.36)	Questionnaire Job-task-exposure matrix
Lee *et al*, 2014 (40)	Hospital cleaners (n = 183)	Prevalence not specified. Chemical-related symptoms (respiratory, ocular, dermal, neurological and gastrointestinal) in the past 12 months	Sprays: 2.82(1.16-6.82)	Carpet cleaners: 2.98 (1.28-6.92) Solvents: 2.71 (1.20-6.15) Multi-purpose cleaners: 2.58 (1.13-6.92)	Questionnaire
Gonzalez *et al*, 2014 (37)	Health workers (n = 543)	Physician diagnosed asthma: 11.2% Physician-diagnosed asthma with onset after entry in the healthcare sector (new-onset asthma): 4.4%	Dilution of disinfectants: 4.01(1.34-12.00) General disinfection tasks: 3.16(1.17-8.52)	Quaternary ammonium compounds: 7.56 (1.84-31.05)	Questionnaire Workplace observations
Arif and Delclos, 2012 (41)	Health workers (n = 3650)	WRAS: 3.3% WEA: 1.1% OA: 0.8%	Not specified	Chloramines: 4.81(1.28-18.06) Cleaners for restrooms and toilets: 4.60(2.12-9.95) Bleach: 3.72(1.70-8.12) Ethylene oxide: 2.97(1.21-7.33) Detergents: 2.84(1.33-6.08) Formaldehyde: 2.66(1.03-6.86) Cleaners/abrasives: 2.50(1.19-5.25) Ammonia: 2.45(1.28-4.69) Glutaraldehyde/OPA: 2.18(1.17-4.07)	Questionnaire

Table 2.1 (continued): Recent epidemiological studies on work-related asthma associated with cleaning agents in the health care setting

Author/ year	Population (n)	Prevalence of asthma phenotypes / symptoms	High risk activities significantly associated with asthma OR / RR (95% CI)	Cleaning agents significantly associated with asthma OR/RR / MR (95% CI)	Tools used for assessment of exposure and asthma-related outcomes
Dumas *et al*, 2012 (42)	Health workers (n=724)	Asthma and report of asthma attacks, respiratory symptoms or asthma treatment in the last 12 months: Men: 39.5% Women: 31.6%	General cleaning/ disinfecting tasks: 2.32(1.11-4.86)	Ammonia: 3.05(1.19-7.82) Sprays: 2.87(1.02-8.11) Decalcifiers: 2.32(1.01-5.31)	Questionnaire Expert assessment Asthma-specific JEM
Vizcaya *et al*, 2011 (13)	Professional cleaners including hospital cleaners (n=917)	Doctor-diagnosed asthma: 9% Asthma attack in the last 12months or woken by an attack of shortness of breath in last 12 months or currently taking any medicine for asthma: 11% Asthma with the first asthma attack at the age of 16 years or later: 5%	Hospital cleaners (activities not specified): 2.1(1.1-4.2)	Carpet cleaners: 2.2(1.0-5.1) Hydrochloric acid: 1.7(1.1-2.6); Ammonia: 1.6(1.0-2.5) Degreasers: 1.6(1.0-2.4) Multiple purpose products: 1.6(1.0-2.5) Waxes: 1.6(1.0-2.6) Air fresheners: 1.5(1.0-2.4) Perfumed products: 1.5(1.0-2.4)	Questionnaire
Arif *et al*, 2009 (12)	Health workers (n=3634)	Doctor-diagnosed asthma with onset after entry into the healthcare profession: 9.8% among nurses BHR-related symptoms: 31.3% among nurses	Building surface cleaning: 1.72(1.00-2.94) Medical instrument cleaning: 1.67(1.06-2.62)	Adhesives, glues and/or solvents for patient care: 1.51(1.08-2.12)	Questionnaire Job exposure matrix

Table 2.1 (continued): Recent epidemiological studies on work-related asthma associated with cleaning agents in the health care

Author/ year	**Population (n)**	**Prevalence of asthma phenotypes / symptoms**	**High risk activities significantly associated with asthma OR / RR (95% CI)**	**Cleaning agents significantly associated with asthma OR/RR / MR (95% CI)**	**Tools used for assessment of exposure and asthma-related outcomes**
Delclos *et al*, 2007 (1)	Health workers (n=3650)	Doctor-diagnosed asthma with onset after entry into the healthcare profession: Overall: 6.6% Nurses: 7.3% Respiratory therapists: 5.6% Occupational therapists: 4.5% Physicians: 4.2% BHR-related symptoms: overall 27.4%	Medical instrument cleaning: 2.22(1.34-3.67) Building surface cleaning: 2.02(1.20-3.40)	Chemical spills: 2.02(1.28-3.21) Adhesives for patients care: 1.65(1.22-2.24)	Questionnaire Job exposure matrix
Kogevinas *et al*, 2007 (35)	General population (n = 6837)	Asthma attack or taking asthma medication in the past 12 months: 4.8% among nurses	Acute symptomatic inhalational event: 3.33(1·00-11·13) Nursing (activities not specified): 2.22(1.25-3.96)		Questionnaire Job exposure matrix Expert assessment Methacholine challenge test
Mirabelli *et al*, 2007 (36)	General population (n = 2813)	Asthma attack in the last 12 months or woken by an attack of shortness of breath in last 12 months or currently taking any medicine for asthma: 6% among nurses	Not specified	Ammonia and / or Bleach: 2.16(1.03-4.53)	Questionnaire IgE test to common aeroallergens

Table 2.1 (continued): Recent epidemiological studies on work-related asthma associated with cleaning agents in the health care setting

Author/ year	Population (n)	Prevalence of asthma phenotypes / symptoms	High risk activities significantly associated with asthma OR / RR (95% CI)	Cleaning agents significantly associated with asthma OR / RR / MR (95% CI)	Tools used for assessment of exposure and asthma-related outcomes
Delclos *et al*, 2006 (43)	Health workers (n=118)	Self-reported history of asthma: 22.9% Prior physician diagnosis of asthma: 20.3% PC_{20} ≤8 mg/ml: 55.1% PC_{20} ≤4 mg/ml: 48.3%	Not specified	Not specified	Questionnaire Industrial hygienist interview Methacholine challenge test IgE test to common aeroallergens IgE test to latex

Bronchial hyper-responsiveness (BHR)-related symptoms: combination of eight questions on asthma and allergy symptoms that had exhibited the best combination of sensitivity and specificity when compared to non-specific bronchial challenge testing with methacholine

WRAS (work-related asthma symptom): wheezing or whistling OR shortness of breath at work that gets better when away from work or worsens on return to work

WEA (work exacerbated asthma): wheezing or whistling OR shortness of breath at work that gets better when away from work or worsens on return to work AND physician diagnosis of asthma AND onset of asthma before entry into health care profession

OA (occupational asthma): wheezing or whistling OR shortness of breath at work that gets better when away from work or worsens on return to work AND physician diagnosis of asthma AND onset of asthma after entry into health care profession

PC_{20}: provocative concentration of methacholine that produced a 20% or greater decrease in forced expired volume in one second (FEV1) from the baseline

JEM: job exposure matrix; **IgE**: Immunoglobulin E; **OR**: odds ratio; **RR**: risk ratio; **MR**: mean ratio

2.5. Pathophysiological mechanisms

The pathophysiology of asthma associated with cleaning agents is not well characterized. It is widely accepted that high molecular weight (HMW) agents, which are commonly proteins such as NRL (commonly associated with donning gloves when using cleaning agents) and proteolytic enzymes cause asthma through immunoglobulin E (IgE)-mediated mechanism (44,45). IgE-mediated immunological mechanisms are also believed to play a major role in occupational asthma induced by some low molecular weight (LMW) agents in non-health care settings (44). However, only a small proportion of individuals with occupational asthma due to most LMW agents have specific IgE in the serum suggesting an IgE-independent immunological mechanism (probably involving cell-mediated and mixed Th1 and Th2 responses) may be playing a greater role (44,46). The mechanism of asthma caused by non-immunological (irritant) mechanisms is not clearly understood. However, it is believed that irritants (such as common cleaning agents - bleach and ammonia) can destroy bronchial epithelium thereby exposing nerve endings and subsequently trigger a neurogenic inflammation characterized by bronchoconstriction, increased mucus secretion and oedema, which are typical features of asthma (44,47). Oxidative stress resulting from persistent imbalance between antioxidants and pro-oxidants as well as the dual irritant and adjuvant effects of some of these chemicals (e.g. formaldehyde and OPA) are also thought to play a role in the pathogenesis of irritant-induced asthma (3,48–50). It is therefore likely that IgE-independent immunological and irritant mechanisms play a greater role in asthma associated with cleaning agents as most cleaning agents are of LMW.

Some animal and human data are available for common disinfectants such as GTA and OPA (25). Experimental studies in mice have shown that GTA and OPA are both dermal and respiratory irritants and sensitizers. Interestingly, OPA was found to be more irritant than GTA in both *in-vitro* EpiDerm Skin Irritation Test and *in-vivo* tests (51). The *in-vitro* EpiDerm Skin Irritation Test is a test used to assess dermal corrosion potential of chemicals and utilizes a normal, human cell-derived, metabolically active skin model closely mimicking the human epidermis (51). There was a concentration-dependent increase in lymphocyte proliferation in the draining lymph nodes of the mice in all three studies reported from the US (51–53), B lymphocytes being the majority in one study (53). In addition, a population of B lymphocytes expressing IgE was also increased in all these studies, in which mice were exposed to GTA (52) and OPA (51,53). Another finding supporting the immunological mechanism caused by OPA and GTA was a predominant expression of Th2 cytokines (IL-4, IL-5 and IL-13) (51–53). The two mice studies reported from Japan also demonstrated the production of specific IgE to OPA (54,55). In the US studies, there was a significantly increase in specific IgE to OPA in mice that were dermally exposed (51), but they were not detected in those exposed through the inhalational route (53). Total serum IgE was also elevated in two studies (51,52).

In some clinical case reports of patients with anaphylaxis due to OPA, skin prick and intracutaneous tests have been used to confirm the presence of sensitization (56–59). More importantly, OPA specific IgE was detected by ELISA in all three patients who developed anaphylaxis due to OPA (59). Furthermore, histamine was released from the basophils of these patients but not from healthy controls (59). However, when basophils from the healthy controls were sensitized to the patient's serum and then exposed to OPA, these cells also released histamine (58). This suggests the presence of an OPA specific heat sensitive component (OPA specific IgE) in the patient's serum capable of sensitising control basophils (58). Recently, a team of National Institute for Occupational Safety and Health (NIOSH) conducted skin prick tests (SPT) and specific IgE and IgG assessment for OPA among 129 US health workers (19). In this US study, 5 (4%) HWs had positive skin responses to SPTs with OPA solution but none had detectable specific IgE and IgG antibodies in any of the blood samples tested (19).

In addition to these immunological data, the clinical history in the case reports of asthma due to OPA and GTA also demonstrated a latency period between first exposure to these agents and development of symptoms implying immunologic response associated with these agents (59,60). Late reactions were also observed in patients that underwent specific inhalation challenge test to GTA, alluding to an underlying allergic mechanism (60).

Nagendran *et al*. identified 4 cases of occupational IgE-mediated allergy to chlorhexidine among 53 HWs in the United Kingdom (UK) hospital (61). Urticaria was reported in all 4 cases identified and in addition one case reporting rhinitis while the other diagnosed with contact dermatitis (61). In this study by Nagendran *et al*., all 3 cases had positive reactions to skin prick tests, while 2 had positive sIgE tests (61). Wittczak *et al*. also described 3 cases of occupational allergy among HWs confirmed by placebo-controlled specific bronchial challenge testing (62). One was diagnosed with occupational asthma, the other having both occupational asthma and rhinitis, while the third had an anaphylactic reaction to chlorhexidine (62). While serum sIgE test to chlorhexidine was positive in all 3 identified cases, only 2 had a positive skin prick test (62). There have been no African studies that have conducted immunological assessment for chlorhexidine in health workers.

2.6. Asthma phenotypes

It is well-known that asthma is a heterogeneous disease with diverse clinical, physiological and inflammatory characteristics (63–65). A number of studies have reported various phenotypes for non-work-related asthma, with significant efforts directed towards characterising the severe asthma phenotypes (64,65). However, studies that have investigated occupational asthma phenotypes are quite limited and most of them have only characterised occupational asthma based on its aetiological agent (e.g. high molecular weight and low molecular weight agents) or according to allergic versus irritant mechanisms (4,63,66,67). The published literature on asthma phenotypes in HWs exposed to cleaning agents is even more scant (3).

2.7. Workplace environmental risk factors and causative agents

The extent of exposure to substances in the health care setting for substances other than NRL and its association with WRA is not well characterised. However, there are a few recent studies in the US and Europe that have attempted to address this issue (36,41). Cross-sectional studies in the US have reported that aside from powdered latex glove usage (pre-2000), occupational exposure to cleaning substances (e.g. instrument cleaning, surface cleaning) and the use of adhesives / solvents are related to asthma after entry into the health care profession (1,12).

2.7.1. Potential hazardous workplace activities

Patient care activities performed by nurses include cleaning surgical and non-surgical instruments, drawing blood, providing wound care and respiratory care, mixing and administering medications, mopping floors, assisting with invasive and other medical procedures and assisting with anaesthesia (12). These activities often involve handling of chemical products or the release of air contaminants, which may pose a potential health risk.

Some population based studies have applied a job exposure matrix (JEM) to categorise chemical agents and workplace activities in the health care sector (1,12,35,68). These studies have identified a number of broad categories of chemical exposures associated with cleaning related activities such as medical instrument cleaning and disinfection; fixed surfaces cleaning and disinfection; floor finishing tasks (stripping, waxing & buffing); patients' skin / wound cleaning and disinfection; specimen preparation; hand hygiene and exposure to aerosolised medications such as pentamidine (12,31,39). Furthermore, accidental chemical exposures and spills are also another exposure context for high-risk workplace exposures (12).

2.7.2. Potential causative agents (asthmagens)

Various studies indicate that the development of occupational asthma is primarily related to the level of exposure to a specific agent in the workplace, and less so to individual host factors such as atopy and smoking, which have produced inconsistent results in a number of studies (69). Broad groups of potential sensitisers and irritants present in health care settings include surface cleaning products (e.g. bleach); disinfectants and sterilants (e.g. glutaraldehyde (GTA) and ortho-phthalaldehyde (OPA)); adhesives/solvents and hand cleaners (e.g. chlorhexidine, triclosan); aerosolised medications (e.g. pentamidine); methacrylates in dental and surgical cements; NRL products; micro-organisms and mildew (11,43,70).

Health workers are commonly exposed to cleaning products that contain respiratory irritants and sensitizers. Most cleaning agents are irritants, however, some have both irritant and sensitising properties. Some of the known irritants in cleaning agents include chlorine, ammonia, hydrochloric acid, monochloramine, sodium hydroxide, quaternary ammonium compounds (e.g. benzalkonium chloride), monoethanolamine (6). Sensitisers known to be present in cleaning agents include, but are not limited to, amine compounds (e.g. monoethanolamine), disinfectants (e.g. GTA and OPA), quaternary ammonium compounds (QACs), scents (e.g. pinene, d-limonene, eugenol), preservatives (e.g. isothiazolinones and formaldehyde) (6).

Delclos *et al* (1) in their studies of asthma in health workers further classified chemical products and agents in the health care sector into three main groups, i.e. instrument cleaning agents, fixed surface cleaners and adhesives/solvents/gases (**Table 2.2**). However, while the specific inventories of chemical products used in the health care setting may not always be generalisable across hospitals in different countries, the active ingredients in these cleaning products are often similar across hospitals.

Medical instrument cleaning / disinfecting agents

Health workers, especially nursing personnel, are exposed to cleaning agents used for high-level disinfection of heat sensitive medical instruments such as endoscopes. Of particular interest are the two aldehydes, GTA and OPA. GTA has been used for over 40 years in health care settings not only for the disinfection of medical instruments but also as a fixative for electron microscopy and x-ray films. Several clinical case reports have been reported in the literature linking GTA and various health effects such as occupational asthma (71,72) and allergic contact dermatitis (73). In 1999, Food and Drug Administration (FDA) approved OPA to be used as a high-level disinfectant. Subsequently, OPA was considered a safer replacement for GTA and is increasingly being used (25). However, OPA has also been recently reported to cause occupational asthma (21,74) and anaphylaxis (56–59) in various case reports, including patients undergoing instrument procedures. In a Japanese study among 70 HWs responsible for endoscope disinfection, 24% had work-related skin, respiratory or eye symptoms due to OPA (27). Work-related symptoms due to OPA were also reported in another Japanese study among 80 female HWs from endoscopy units, with respiratory symptoms being the majority (16%), followed by skin (10%) and eye (9%) symptoms (24).

Other cleaning agents used for disinfection of medical instruments include QACs, hydrogen peroxide, a mixture of hydrogen peroxide and peracetic acid and a mixture of hydrogen peroxide, peracetic acid and acetic acid. Respiratory and ocular symptoms have been reported in individuals exposed to hydrogen peroxide and a mixture of hydrogen peroxide, peracetic acid and acetic (75,76). In recent years, there has been an increase in the use of enzymatic cleaners for pre-cleaning of medical instruments prior to high-level disinfection in health care settings (1,77). Two studies have reported cases of occupational asthma and rhinitis among HWs using enzymatic cleaners (77,78). Exposure to proteolytic enzymes has long been recognised as a cause of allergic respiratory and skin symptoms particularly among detergent manufacturing workers (1,77).

The association between asthma and cleaning agents used for medical instrument disinfection has also been demonstrated in epidemiological studies and surveillance systems (12,39,79,80). In a recent study among US nurses (39), medical instrument disinfection (OR = 1.88; 95% CI: 1.38 to 2.56) and exposure to formaldehyde, glutaraldehyde, hypochlorite bleach, hydrogen peroxide and enzymatic cleaners was associated with poor asthma control. A study by Arif *et al* (12) reported a significantly higher odds of reported asthma among HWs exposed to medical instrument cleaning agents (OR = 1.67; 95% CI: 1.06 to 2.62). Six percent of occupational asthma cases reported to a surveillance system in the United Kingdom were attributable to GTA (79). Although not specified, it is probable that most, if not all of these cases were from heath care settings, where GTA was commonly used.

Fixed surface cleaning agents

Fixed surface cleaning is an inherent aspect of activities performed in the health care setting. Cleaners and janitors are widely reported to be high-risk occupations in both industrialised and developing countries (3,81–83). In a US surveillance study (84), janitors, cleaners and housekeepers formed the largest (22%) occupational group in which exposure to cleaning products was associated with WRA, followed by a group of nurses and nurse aides (20%). In this study, the health sector had the highest number (39%) of patients with WRA due to cleaning products.

For general cleaning purposes, Medina-Ramon *et al* (85) found bleach, ammonia and hydrochloric acid as the most commonly used irritant cleaning products used in a diluted or undiluted form, with airborne chlorine and ammonia detected during cleaning activities. A Spanish study among cleaning workers also reported an increased risk of asthma symptoms in workers that used hydrochloric acid (mean ratio [MR] = 1.7; 95% CI: 1.1 to 2.6), degreasers (MR = 1.6; 95% CI: 1.0 to 2.4), air fresheners (MR = 1.5; 95% CI: 1.0 to 2.4) or ammonia (MR = 1.6; 95% CI: 1.0 to 2.5) in the last year (13). A number of studies have demonstrated a positive association between use of cleaning sprays and asthma or respiratory symptoms (39,40,42,86–90). Use of sprays generates more aerosols and hence facilitates inhalational exposure.

Cleaning agents comprised the most common group of agents reported (20.5%) among individuals with suspected occupational asthma presenting with acute asthma symptoms to the emergency units of the two large public tertiary referral hospitals in Cape Town (91). The study by Kogevinas *et al* (35) demonstrated a 1.8 fold (RR = 1.80; 95% CI: 1.01 to 3.18) increased relative risk for asthma with the use of cleaning products (including different occupations and sectors in the analysis). A similar finding was observed among nurses in a study by Arif *et al* (12) that showed a significantly higher odds of reported asthma for exposure to general building cleaning agents and disinfectants (adjusted OR = 1.72; 95% CI: 1.00 to 2.94). According to a large scale European based study, nurses that reported using ammonia and / or bleach were found to have a more than two-fold (RR = 2.16; 95% CI: 1.03 to 4.53) increased risk of developing new-onset asthma (36). An increased relative risk for asthma (RR = 1.51; 95% CI: 1.36 – 1.66) has also been reported among cleaners in the Finish health care setting (92).

Apart from the individual effect of cleaning agents, newly produced asthmagens can be produced when different cleaning agents are mixed together (6). Chloramines may be released when hypochlorite from bleach is mixed with ammonium salts from cleaning products or body fluids (6). Chloramines have been reported to cause occupational asthma among pool workers (93). Recently, increased numbers of occupational asthma cases have been reported among cleaners that used chlorine-based cleaning agents (sodium hypochlorite and sodium dichloroisocyanurate) (80). Interestingly, specific bronchial challenge tests to these cleaning agents were negative and only became positive when challenged with a mixture of urine and chlorine-based cleaning agents (and hence producing chloramines) (94). On the other hand, chlorine, a common respiratory irritant is generated when acid is mixed with bleach (84). Application of some cleaning agents can also yield high levels of volatile organic compounds (VOC) that can also act as airway irritants (6,95). This suggests that there is potential for multiple exposures among workers who are involved in cleaning-related tasks.

Agents used for patient skin / wound cleaning and disinfection

Chlorhexidine, povidone iodine and alcohols are one of the most commonly used agents for disinfection of wounds and patients' skin prior to various medical procedures. Walk-through surveys performed by occupational hygienists in US hospitals revealed that routine patient care activities performed by nurses often included the use of adhesives and adhesive removers, particularly in surgical and intensive care units (1,12). These compounds are used to apply and/or remove dressings and adhesive bandages, as well in case of stoma care. The compounds may contain respiratory irritants such as dimethyl ether, dipropylene glycol methyl ether and isoparaffinic hydrocarbons, and may be administered in an aerosolised form. Arif *et al* (12) also found an almost twofold increased odds of asthma among nursing professionals that were exposed to adhesives, adhesive removers and / or solvents. Furthermore, Pechter *et al* (70) reported that exposure to solvents accounted for 7% of reported WRA, and various chemicals (including glues and solvents) were associated with asthma among 29% of aides and therapists in the US.

Agents used for hand hygiene (hand washing/sanitising)

Exposure to chemicals contained in hand hygiene products is quite common in hospital settings since HWs are required to wash and disinfect their hands several times per day in order to comply with infection control standards. Alcohols and chlorhexidine are the most commonly used agents for hand hygiene in hospital settings (31,61,62). Chlorhexidine is a known sensitiser and irritant to both the skin and airways (31). There have been a few published reports of asthma and dermatitis due to chlorhexidine, mostly among patients and few occurring in HWs (61,62,96–98). Povidone iodine is also used commonly for hand washing (31). Povidone iodine is a well-known skin irritant but its sensitising properties have not been well characterised (99). Triclosan, also used as hand cleaner in the health care setting, has been implicated in the causation of adverse health effects affecting the skin such as allergic contact dermatitis and contact urticaria as well as occupational asthma (100–103).

Table 2.2: Cleaning agents associated with work-related asthma in health care workers

Instrument cleaning/disinfection	Fixed surface cleaners	Adhesive removers and hand cleaners / disinfectants
Glutaraldehyde Hydrogen peroxide Isopropanol Ortho-phthalaldehyde Quaternary ammonium compounds Sodium sesquicarbonate Subtilisins (enzymatic cleaners)	Acetic acid/acetic acid anhydride Ammonia/ammonium hydroxide Bleach Butyl paraben, ethyl paraben, methyl paraben Diethanolamine Diethylene-glycol n-butyl ether Hydrochloric acid Isoparaffinic hydrocarbons Phosphoric acid Quaternary ammonium compounds Sodium sulfate Sulfuric acid	Adhesive removers • Acetone • Dipropylene glycol methyl ether • Ethanol • Isoparaffinic hydrocarbons • Isopropanol Stoma care products • Carboxymethyl ether • Hexane-based skin bond • Methylbenzene Hand cleaners / disinfectants • Chlorhexidine • Alcohols • Povidone iodine • Triclosan Other • Methylene chloride • Trichloroethane

Source: Modified from (1)

2.7.3 Dose-response relationships

Little is known regarding exposure-response relationships between exposure to specific cleaning agents and asthma-related outcomes. A few studies have only reported exposure-response relationships for broad categories of cleaning-related exposures with very limited information on specific cleaning agents (41). Arif *et al*. demonstrated exposure-response relationships for work-exacerbated asthma in HWs who used disinfectants for medical instrument disinfection as well as for work-related asthma symptoms in HWs who used cleaning agents for fixed surfaces cleaning/disinfection (41). Medina-Ramon *et al*. demonstrated dose-response relationship between use of bleach and asthma among domestic cleaners in Spain (17). Similarly, Zock *et al*. demonstrated dose-response relationships for asthma with the frequency of use of cleaning sprays as well as with increasing number of the types of sprays used (86). In a recent study by Dumas *et al*., poor asthma control was positively associated with increased frequency of hand hygiene practices among US nurses, with clear dose-response relationship demonstrated for surgical hand/arm hygiene (31).

2.8. Host-associated risk factors

Common host-associated factors that have been associated with asthma include age, gender, seniority, smoking status and atopy (1,12). Delclos et al (1) demonstrated that increasing seniority was positively associated with reported asthma. The study by Kogevinas *et al* (35) of workers across different industries, demonstrated that atopic individuals had a significantly higher relative risk (RR = 2.9; p-value = 0.019) for new-onset asthma than non-atopics. The study also demonstrated an increased risk of new-onset asthma in participants with a parental history of asthma (RR = 2.1) and in non-smokers (RR = 1.8) compared to current smokers.

There is inconsistent evidence with regard to the association between smoking and asthma in general and with occupational asthma in particular (3,63,104). While some studies have demonstrated that smoking at baseline increased the risk of incident asthma in adulthood, no significant association was reported in a follow-up cross-sectional analysis (105). Furthermore, very limited specific information is available on the risk of smoking in relation to asthma among HWs exposed to cleaning agents (104,106). The study by Zock *et al*. in cleaning workers did not demonstrate any association between smoking and asthma (106).

Risk factors for non work-related adult-onset asthma and occupational asthma have also been reviewed in a comparative manner (63). This review found that while host associated factors (e.g age, gender, genetics, atopy and obesity) did not differ for these two broad asthma phenotypes, environmental factors appeared to play a very important role in occupational asthma. Recently, Rava *et al*. (107) identified novel genes associated with adult asthma related to occupational exposure to LMW agents / irritants in three large European cohorts (Epidemiological family-based study of the Genetics and Environment of Asthma, Swiss Cohort Study on Air Pollution and Lung and Heart Diseases in Adults and ECRHS).

Female HWs appear to be more affected than men. In a study (41) of US HWs, females had a higher prevalence of all asthma phenotypes that included WRA symptoms (3.6% vs 1.8%), work exacerbated asthma (1.3% vs 0.3%) and occupational asthma (1.0% vs 0.1%) than their male counterparts. Similar findings were reported in a large population European study (35) that found a slightly higher relative risk of new-onset asthma among women (RR = 1.13) compared to men. It is likely that the gendered distribution of work plays a role. Interestingly, female sex hormones have been implicated in the pathogenesis (63).

2.9. Prevention

Several studies have proposed preventive strategies for work-related asthma related to cleaning agents (3,5,108). However, not enough effort has been directed towards the implementation of the suggested preventive strategies that target relevant stakeholders such as government agencies, manufacturers of cleaning products, suppliers and commercial cleaning companies (3,5).

Primary prevention is usually the most effective strategy but not always feasible (109). Some of the primary prevention strategies that have been proposed include substitution of certain cleaning agents such as glutaraldehyde, QACs, bleach and ammonia with less hazardous agents (3,5). One of the challenges of this method has been the difficulties associated with finding the proper alternative cleaning agent/s and the lack of information regarding health effects of the newer cleaning agents. This has lead to replacement of a known hazard, such as GTA, with a potentially unknown hazard (e.g. OPA), that was later demonstrated to cause similar health effects (25). Quantitative structure-activity software that can predict sensitisation potential of chemicals may be very useful for decisions regarding new cleaning agents to be introduced in the workplaces (110). Avoidance of mixing cleaning products such as bleach and ammonia has also been strongly advocated (5,6).

Engineering controls are very important in reducing cleaning-related exposures. Ideally, proper ventilation should be maintained in all areas where cleaning agents are used. However, this is quite rare since cleaning agents are used almost everywhere. Local exhaust ventilation (LEV) systems should be installed in certain dedicated areas where a specific cleaning and disinfection is performed on a regular basis such as in areas where medical instrument cleaning and disinfection is taking place. A recent US study (19) has proposed specific ventilation standards for areas where OPA is used for high-level disinfection of medical instruments. Since exposure to cleaning sprays is an important risk factor for work-related asthma (86), use of wipes rather than sprays could be very effective in reducing the burden of work-related asthma due to cleaning agents.

Administrative controls such as provision of occupational health and safety (OHS) education; establishing written policies on how to properly use cleaning agents; supervision to make sure proper work practices are followed while working with cleaning agents; and preventive maintenance of the ventilation systems are also very important in the prevention of work-related asthma associated with cleaning agents. However, little is known regarding the effectiveness of the suggested administrative control measures in reducing incidence of WRA related to cleaning agents. An intervention involving collaboration between a cleaners' union and other stakeholders including OHS technical personnel in the US was successful in eliminating the use of the most hazardous cleaning agents, reducing the number of different cleaning agents used, banning mixing of cleaning agents, and enhancing safety training (111).

It is well known that the use of personal protective equipment (PPE) is the least effective method for the control of work-related hazards. Full support of the employer with involvement and commitment of employees is required to ensure the proper use of PPE. Use of PPE is usually advised since the most effective means for controlling cleaning-related exposures such as engineering methods are usually absent in most workplaces. Some of the PPE advised for controlling cleaning-related exposures include use of proper respirators with vapour and gas cartridges, eye protection (e.g. goggles or face shields), fluid repellent gowns or aprons, proper gloves (e.g. nitrile gloves) and proper shoes (19).

Medical surveillance for HWs that work regularly with cleaning agents is also recommended. The aim of this mode of secondary prevention is to detect the disease at an early stage in order to prevent the development of severe adverse health effects. Occupational health practitioners can use medical surveillance information to determine the effectiveness of the available preventive measures. Questionnaire interviews and spirometry are commonly used for medical surveillance in various workplaces. However, the use of immunological tests can be very helpful in the surveillance of HWs using cleaning agents with sensitising properties (112,113).

2.10. Conclusion

Cleaning agents have become the major causative agent of WRA among HWs due to their extensive use in the health care settings. More efforts need to be directed towards characterising cleaning-related exposure in a more detailed manner so as to obtain more specific information such as cleaning agents and tasks associated with WRA in HWs as well as the frequency and duration of use. Furthermore, future studies need to use more objective measures of exposure assessment for cleaning agents in the health care setting. There is a need for larger prospective studies in HWs exposed to cleaning agents using various clinical, physiological and inflammatory markers such as Fractional exhaled nitric oxide (FeNO) test, serum specific IgE or skin prick tests, sputum eosinophils, serum periostin and lung function testing in order to further characterise the asthma phenotypes in these workers. In addition, more efforts need to be directed towards characterising exposure-response relationships and host-associated risk factors (e.g. atopy, gender, and smoking) in HWs exposed to cleaning agents. More studies are needed to have a better understanding of the association between novel genes and adult-onset asthma due to occupational exposure to low-molecular weight agents/irritants in order to develop more specific preventive strategies for WRA associated with cleaning agents in health care settings.

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CHAPTER 3

METHODS

3.1. Study design, Population and Sampling

A cross-sectional study of **699** HWs was conducted in two large tertiary academic hospitals (**346** from a South Africa hospital – SAH and **353** from Tanzanian hospital - TAH) during the period July 2014 and March 2018. Following meetings with several key stakeholders and walk-through inspections by the investigators of both hospitals, specific departments were identified as potentially high-risk exposure settings for cleaning agents. Health workers in these high-risk departments used significant amounts of cleaning agents at a frequency much higher than other departments. The departments identified in the SAH included out-patient clinics, intensive care units (ICUs), operating theaters, emergency units, ENT ward, vascular radiology and the haemodialysis unit. The out-patient clinics, ICUs, operating theaters, emergency unit, Central Sterile Services Department (CSSD) and haemodialysis unit were identified in the TAH (Table 3.1 and 3.2).

Table 3.1: Permanently employed health workers in high risk areas at the South African Hospital

	Nurses	Cleaners	Technicians	Porters	Clerks	Total
Out-patient clinics	63	8	17	5	11	104
Intensive care units	225	26	8	1	10	270
Operating theaters	152	3	29	18	3	205
Emergency units	81	11	0	0	11	103
ENT ward	11	4	0	0	1	16
Vascular radiology	10	6	4	6	0	26
Hemodialysis unit	19	4	8	0	4	35
Total	561	62	66	30	40	759

Table 3.2: Permanently employed health workers in the high risk areas at the Tanzanian Hospital

	Registered nurses	Enrolled nurses	Health attendants	Cleaners	Technicians	Clerks	Total
Out-patient clinics	16	7	17	28	1	3	72
Intensive care units	68	8	25	15	0	1	117
Operating theatres	93	23	69	5	0	3	193
Emergency unit	43	9	38	12	0	25	127
Central Sterile Services Department	3	6	12	0	3	0	24
Hemodialysis unit	17	1	6	2	0	1	27
Total	240	54	167	62	4	33	560

Sampling strategy

All permanently employed HWs in the high-risk departments constituted the sampling frame of the study. Doctors were excluded from the sampling frame as they were more likely to work in multiple different exposure settings across the hospital. A list of all permanently employed HWs in the high-risk departments was obtained from their respective managers. Study participants were selected from these departments through stratified random sampling according to job title, choosing up to five HWs from each high-risk department. For departments having more than five HWs with the same job title, a random sample of five workers was selected. For departments having less than five workers, all workers were selected to participate in the study. Selected HWs who could not participate in the study were replaced by fellow HWs using a similar method (stratified random sampling). The overall response rate was 53%, with a higher response rate in the TAH (63%) compared to the SAH (46%) (Appendix J).

Sample size calculation

Based on information from the literature the estimated sample size was calculated using a mean prevalence of 6% based on a prevalence of 4.8 – 7.3% for work-related asthma reported in the literature (1,2). The following parameters were used to obtain an estimated sample size of **347** for each hospital as outlined in Table 3.3.

Table 3.3: Sample size parameters used in calculations

Parameter	value
Anticipated proportion of work-related asthma	0.06
Expected precision	0.025
Alpha level	0.05

3.2. Exposure assessment

3.2.1. General exposure assessment

A list of cleaning agents used in the two hospitals was obtained from the supply chain department of the respective hospital. Information was also obtained about the type and volume of chemicals used in the various departments of the hospital to confirm a priori high-risk departments. The most recent safety data sheets (SDS) of the cleaning products were obtained from the supply chain department and/or from suppliers/manufacturers directly. Walk-through surveys were conducted in both hospitals using a proforma checklist. The surveys were conducted by a team that included an occupational hygienist and occupational medicine specialist. The team members also conducted short interviews with the operational managers of the respective work area. During the walk-through survey, each member of the team conducted their own independent evaluation. After evaluating each specific work area (department), the team members convened for a short discussion to have a consensus decision on the relevant exposures pertaining to that department. Discrepancies in findings were resolved by consensus and the findings recorded on the checklist. The research team also communicated with the supply chain departments and nurse managers on a regular basis to ensure that any new products that were introduced during the study period also formed part of the assessment.

3.2.2. Environmental sampling of aldehydes

Measurement of aldehyde concentrations in the air was initially conducted in the SAH. A subsequent pilot sampling study in the TAH revealed very low levels of OPA and glutaraldehyde and as a result extensive environmental sampling was not done in this hospital. In the SAH, measurements of aldehydes were conducted in the 17 departments where OPA and enzymatic cleaners were used for cleaning and disinfection of medical instruments. This decision was informed by the initial walk-through survey findings. Selection of workers for OPA monitoring was limited to those on a day-shift for logistical reasons. On the earmarked sampling day, workers in each department were classified into high, medium and low/no exposure based on the results of the walk-through survey. Workers working directly with OPA were classified into a high exposure group; workers performing patient care activities were classified into a medium exposure group; and administrative workers were classified into a low/no exposure group. A random sampling strategy was employed to select workers in each stratum (high, medium, low/no exposure) for OPA air monitoring in each department. The random selection was based on using sample size calculations of the top 20%, employing a 95 percent confidence level (3). A total of 269 full-shift passive personal samples were collected from 164 HWs randomly selected from 17 different departments. Among the 164 workers selected, 70 (43%) were sampled once, 83 (50%) sampled twice and 11 (7%) were sampled thrice.

Passive sampling used TraceAir® AT580 monitors (Assay Technology, Livermore, CA). TraceAir® AT580 monitors containing a fibreglass strip treated with 2,4-dinitrophenylhydrazine (DNPH) for sampling aldehydes including OPA. The OPA reacts with DNPH in the monitor to yield an OPA-DNPH derivative. Field blanks were included in every day of passive sampling. All samples were stored at 4 degrees Celsius after collection until analysed. Analysis was conducted within four weeks of sample collection.

Samples were analysed for OPA, glutaraldehyde and formaldehyde using OSHA method 64 and NIOSH method 2016 in a South African National Accreditation System (SANAS) accredited laboratory (Chemtech laboratory services). Two millilitres of Acetonitrile:dimethylsulfoxide (90:10) was added to extract the OPA-DNPH derivative from the monitors. The samples were left to desorb for 30 minutes, to ensure that all the analytes were dissolved in solution. Samples were analysed using an Agilent 1100 series High Performance Liquid Chromatography (HPLC) with a Variable Wavelength Detector (VWD). The column used was a Phenomonex Luna 5um C18 reversed phase. An acetate buffer was used, which contained 5 g of ammonium acetate adjusted to pH 6 with acetic acid. Acetonitrile was used as the organic solvent. The method used was 19.00 minutes in length. The flow rate was 1.5 ml/min. An isocratic mixture of buffer: acetonitrile (30:70) was used as the mobile phase. The injection volume was 20 µl, and the column temperature was controlled at 40°C. The VWD was set to 360 nm. Samples were integrated with Chemstation, where a calibration was setup beforehand. The calibration was setup by means of an external standard. A calibration stock of OPA-DNPH derivatives were obtained from Supelco. Calibration standards ranged from 1ppm to 10 ppm. A linear calibration curve was constructed and was forced through 0, with a regression of 0.99910.

3.2.3. Biomonitoring for chlorhexidine

Chlorhexidine biomonitoring was conducted in the SAH only since none of the HWs in the TAH used chlorhexidine. Urine samples for chlorhexidine biomonitoring were collected from the study participants during their health outcome assessment visit to the study venue. Spot urine samples (50 ml) were collected from 336 participants in a clean indoor toilet using a plastic container topped with a plastic cap. To avoid contamination, participants were instructed on specific precautions on washing hands before handling containers; not touching the inside of the container; collecting the midstream urine and covering the containers immediately after producing the sample. The samples were stored in the refrigerator at 4 degrees Celsius at the study venue and then transported on dry ice to the permanent storage facility on the same day of sample collection. The samples were stored at -80 degrees Celsius before being analysed at the Clinical Pharmacology laboratory at the University of Cape Town by a team led by Dr Lubbe Wiesner.

While the initial plan of the biomonitoring component was to develop a multiplex assay for the determination of chlorhexidine and its metabolites (*p*-chloroaniline and 1-chloro-4-nitrobenzene) in urine, due to logistical reasons it was only possible to develop a method for p-chloroaniline (PCA). The urine samples were analysed using a LC-MS/MS method developed in-house based on the detection of PCA. The samples were thawed at room temperature and extracted with 4 volumes of a 1:1 mix of 0.1% formic acid and acetonitrile, containing 62.5ng/ml *p*-bromoaniline as internal standard. The supernatant following centrifugation was transferred to a 96-well plate for LC-MS/MS analysis. Calibration standards and quality control samples were prepared by spiking PCA in blank urine to give final concentrations between 1 – 3125ng/ml. These were then extracted as described and analysed together with the patient samples to provide a standard curve from which patient PCA levels were determined. LC-MS/MS was performed on an ABSciex 4000Qtrap® mass spectrometer coupled to an Agilent 1200 Rapid Resolution HPLC system. Chromatography was achieved using a Kinetex F5 column (100 x 4.6mm, 2.6µ) using 0.1% formic acid as the aqueous mobile phase and 0.1% formic acid in acetonitrile as the organic phase. An isocratic method at 0.8ml/min was run, with a 1:1 split between the MS and waste. Carry over was avoided using a needle wash consisting water, acetonitrile, methanol, isopropanol and formic acid (30:30:30:10:0.1). Analyst 1.6 software was used for instrument control, data acquisition and analyte quantitation.

3.3. Health outcome assessment

3.3.1. Questionnaire

A total of **697** participants completed the questionnaire interviews (**344** from SAH and **353** from TAH). Each participant answered a modified questionnaire for the investigation of asthma as contained in the Protocol for the European Community Respiratory Health Survey (4). The study questionnaire also included validated questions from the NIOSH specific questionnaire for cleaning agents in the health care setting (5). The questionnaire was administered by trained interviewers in English language for South African health workers (SAHWs) and in Swahili language for Tanzanian health workers (TAHWs). The translated Swahili questionnaire was back-translated to ensure validity and repeatability.

3.3.2. Immunological assessment

Blood samples were collected from **682** participants (**339** SAHWs and **343** TAHWs). Specific IgE antibody reactivity to common aero-allergens (Phadiatop) and specific occupational allergens was evaluated. The quantification of specific IgE antibodies to specific occupational allergens: NRL (*Hevea brasiliensis* - Hev b5, Hev b6.02), chlorhexidine and OPA was performed using the UniCAP system (Phadia, Uppsala, Sweden). Immunological assessment for chlorhexidine was only done on sera of SAHWs since chlorhexidine containing chemicals were not used in the TAH.

Commercial ImmunoCAPs containing Phadiatop (Phad), Chlorhexidine (C8), rHev b5 (K218) and rHev b6.02 (K220) allergens were obtained from Thermo Scientific. Serum samples were tested at the National Institute for Occupational Health (NIOH) Immunology laboratory (Dr Tanusha Singh) using the UNICAP 250 machine supplied by Thermo Scientific according to the manufacturer manual. This instrument uses the fluorescent enzyme immunoassay (FEIA) technique in an automated process. Briefly, serum is added to allergen of interest that is covalently coupled to ImmunoCAP. If specific IgE is present in the serum being tested, it will bind to the antigen and form an antigen–antibody complex. After washing away non-specific IgE, a fluorescent labelled anti human immunoglobulin is added that binds to the unwashed antigen–antibody complex. The fluorescent colour is converted into specific IgE concentrations by the machine software.

Since the OPA test was not readily available commercially, it required further development. Ortho-phthalaldehyde (OPA) was coupled to albumin using a modification of the ELISA method by Suzukawa *et al*., 2007, Anderson *et al*., 2010 and Johnson *et al*., 2011 (6–8). A 4% (40mg in 1ml) solution of bovine serum albumin (BSA) (GE healthcare life sciences, cat no: SH30574.02) was prepared in phosphate buffered saline (PBS) (Roche, cat no: 11 418 165 001) and a 2.2 % (22mg in 1ml) solution of OPA (Sigma, cat no: P1378-5G) was prepared in sterile water. Equal amounts (500µl) of BSA and OPA solutions were mixed resulting in a final concentration of 2 % BSA and 1.1 % OPA.

This mixture was labelled with Biotin and separated on a Sephadex G-25 column using the Biotin labelling kit from Roche according to the manufacturer's instructions (Roche, cat no: 11 418 165 001). Briefly 6.7µl of Biotin-7-NHS was added to the BSA/OPA mix and incubated for 2 hours at 15-25^{0}C while stirring. The Sephadex G-25 column was prepared by adding 5 ml of blocking solution to the column and allowed to flow through. Thereafter, the column was rinsed 6 times with 5ml of PBS. The biotin labelled protein mixture was added to the column. This was then eluted with 3.5ml of PBS and 40 drops of labelled protein was collected and used as the allergen.

The ImmunoCAPs were then washed and placed in a 2ml Eppendorf with a pipette tip. These were then centrifuged to get rid of the glycerol for 2 min 1450g. ImmunoCAPs were washed and centrifuged 4 times with 50 µl ImmunoCAP Washing solution. Washed ImmunoCAPs were placed in a microtiter plate and 50 µl of biotinylated allergen was added into each ImmunoCAP. After 30 minutes the ImmunoCAPs were put into a carrier and loaded into the Phadia250 machine. Specific IgE antibodies to prepared OPA allergens were then measured using the UNICAP 250 machine according to manufacturer's procedure.

3.3.3. Spirometry (pre and post-bronchodilator) only

Three hundred and thirty one (**331**) participants from the TAH and, as explained further in the next section, only **25** participants from the SAH performed spirometry (pre- and post-bronchodilator). The latter group did not proceed to methacholine challenge testing (see below) due to contra-indications (e.g. FEV_1 below 1.5 litres or 70% predicted, pregnant and breastfeeding women). Spirometry was conducted according to guidelines of the American Thoracic Society/European Respiratory Society (ATS/ERS) (9) using EasyOne World spirometer (ndd Medical Technologies, Zurich, Switzerland) at the TAH and Jaeger Aerosol Provocation System (APS) Pro apparatus connected to a computer at the SAH, according to the manufacturer's instructions. In the SAH, spirometry was conducted by an experienced technologist in the same pulmonary function laboratory, where methacholine challenge tests were also performed. Since a portable EasyOne spirometer was used in the TAH, spirometry was conducted by experienced nurses in the pulmonary function laboratory as well as in the respective departments. Spirometers were calibrated at least twice a day with a three-liter syringe. The temperature and humidity were monitored on a daily basis. Spirometry was performed in a sitting position with nose clips. Each HW performed no more than eight trials to produce three acceptable curves. The lung function indices of primary interest were forced vital capacity (FVC) and forced expiratory volume in one second (FEV1). The best FEV1 and FVC were used regardless of whether they belong to the same tracing. Special instructions were given to health workers to abstain from smoking tobacco (at least 2 hours before) taking any anti-asthmatic inhalers (12 hours before) or oral asthma medications (48 hours before) prior to the test. The Global Lung Function Initiative (GLI) 2012 reference values using "other" ethnic group were used for grading degree of impairment of spirometry (10). A change in FEV_1 of ≥200 milliliters and ≥12% 10 minutes after the administration of bronchodilator (400 µg of salbutamol) was considered to be significant bronchial reversibility. To achieve additional quality control for the Tanzanian group that did not perform methacholine challenge tests (due to logistical considerations), each spirometric test was evaluated for the quality according to the ATS standards (11) as outlined in Table 3.4, which compares grading between the Easyone spirometer output and the ATS grading. All spirometric tests with ATS quality grade F were not included in the analysis. Three (**3**) participants with ATS quality grade F on their pre-bronchodilator (pre-BD) tests were not allowed to proceed to post-BD testing (Table 3.4). Data from **182** participants were available after excluding those with ATS grade D, E and F on pre-bronchodilator (pre-BD) tests.

Table 3.4: Spirometry quality grades of health workers in the Tanzanian hospital

	Pre-BD Easyone grade n (%)	**Pre-BD ATS grade** n (%)	**Post-BD Easyone grade** n (%)	**Post-BD ATS grade** n (%)
A	86 (26)	129 (39)	132 (41)	175 (54)
B	43 (13)	69 (21)	43 (13)	40 (12)
C	102 (31)	34 (10)	57 (18)	18 (6)
D	97 (29)	9 (3)	75 (23)	13 (4)
E		87 (26)		61 (19)
F	3 (1)	3 (1)	18 (6)	18 (6)
Total	331	331	325	325

Note: Those with ≥2 acceptable tests with repeatability of > 0.250 L were assigned ATS grade E

3.3.4. Methacholine challenge tests including spirometry

Methacholine challenge testing (MCT) was only performed in the South African study site due to logistical considerations. The tests were conducted in a pulmonary function laboratory that was well equipped with appropriate resuscitation facilities. Among **318** participants who underwent spirometry, **239** performed interpretable PD_{20} methacholine results while **52** participants had ≥10% decrease in FEV_1 after administration of saline diluent and were therefore not considered for MCT. MCT was discontinued in **two** participants who requested the test to be stopped. As explained above, **25** participants underwent post-bronchodilator spirometry, since MCT was contraindicated. MCT was conducted under the supervision of an experienced technologist according to an abbreviated protocol used in epidemiological surveys. The Medic Aid Pro Nebulizer dosimeter method involved a protocol of increasing numbers of breaths to achieve pre-defined cumulative doses of methacholine (12). The doses were delivered by the Jaeger APS MedicAid Side Stream APS-Nebulizer according to the manufacturer's instructions, commencing with the lowest dose of 0.026 mg. The dose was increased to a maximum of 2.048 mg methacholine if a positive endpoint (fall in FEV_1 of 20% or more) was not obtained. The results of the MCT were interpreted as follows: borderline defined as 0.4mg $<PD_{20}M<$1.0 mg; mild = 0.08 mg $< PD_{20}M <$0.4mg; moderate/severe = $PD_{20}M<$ 0.08mg. Borderline values for $PD_{20}M$ were considered negative in the definition of non-specific bronchial hyper responsiveness (NSBH). These cut-offs for the APS system are based on the results from a validation study performed on 40 hyper-responsive bakery workers that confirmed a satisfactory correlation between the APS cumulative $PD_{20}M$ method and the standard VMAX (Sensormedics) method (13). A urine pregnancy test was offered to women prior to the administration of methacholine, while pregnant women and nursing mothers were automatically excluded from testing.

3.3.5. Fractional exhaled nitric oxide (FeNO)

A total of **654** participants performed FeNO tests (**334** from SAH and **320** from TAH). A hand-held portable exhaled nitric oxide sampling device (NIOX MINO® Airway Inflammation Monitor (NIOX MINO); Aerocrine AB, Solna, Sweden) was used. Under guidance of clinical personnel, all HWs inhaled NO-free air close to total lung capacity and exhale for 10 seconds at a flow rate of 50 ml/sec according to the manufacturer's instructions. Two technically adequate measurements were performed in line with the current American Thoracic Society /European Respiratory Society recommendations (14). A third maneuver was performed if the difference between the first two measurements was more than 10 ppb. The FeNO test was done during the work shift before spirometry / MCT. Special instructions were provided to workers to ensure that tested individuals did not smoke tobacco, eat or drink (at least 1 hour before) prior to the test. Ambient NO and temperature were also recorded.

3.3.6. Operational definitions of asthma phenotypes and predictor variables

Information on which the asthma phenotypes were based was obtained from the questionnaire, immunological tests, spirometry (pre- and post-bronchodilator), methacholine challenge tests and FeNO levels. An asthma symptom score was computed based on the sum of answers (0=no, 1=yes) to five questions on asthma-like symptoms in the past 12 months (short of breath while wheezing, woken up with chest tightness, attack of shortness of breath at rest, attack of shortness of breath after exercise, woken up by attack of shortness of breath), as has been described previously (15–18). A binary variable was created from these five asthma-like symptoms (≥ 2 symptoms vs 0-1 symptom). Having≥ 2 asthma-like symptoms was considered ‘more symptomatic’ and 0-1 asthma-like symptom ‘less symptomatic’.

Current asthma was defined as either having an asthma attack in the past 12 months, current use of asthma medication or woken up by an attack of shortness of breath in the past 12 months (17,19,20). Atopic asthma was defined as either having an asthma attack in the past 12 months, current use of asthma medication or woken up by an attack of shortness of breath in the past 12 months; and presence of atopy. Nonatopic asthma was defined as either having an asthma attack in the past 12 months, current use of asthma medication or woken up by an attack of shortness of breath in the past 12 months; and being nonatopic. Work-related asthma was defined as either having an asthma attack in the past 12 months, current use of asthma medication or woken up by an attack of shortness of breath in the past 12 months; and work-related chest symptoms in the past 12 months that gets better when away from work or worsen on return to work.

Work-relatedness of asthma symptoms was determined based on the positive responses to the following questions (Figure 3.1): “Does being at work ever make your chest tight, wheezy, or short of breath? If Yes: In the last 12 months, have you experienced these chest symptoms while you were at work at any time? If Yes: While you were away from work (for e.g. on weekends, off-shift, or on vacations) at any time in the last 12 months, did your chest symptoms seem *better*, worse, or the same? After returning to your work at any time in the last 12 months, did your chest symptoms seem better, *worse*, or the same?” (21). Work-relatedness of ocular-nasal and skin symptoms was determined using a similar approach (Figure 3.1).

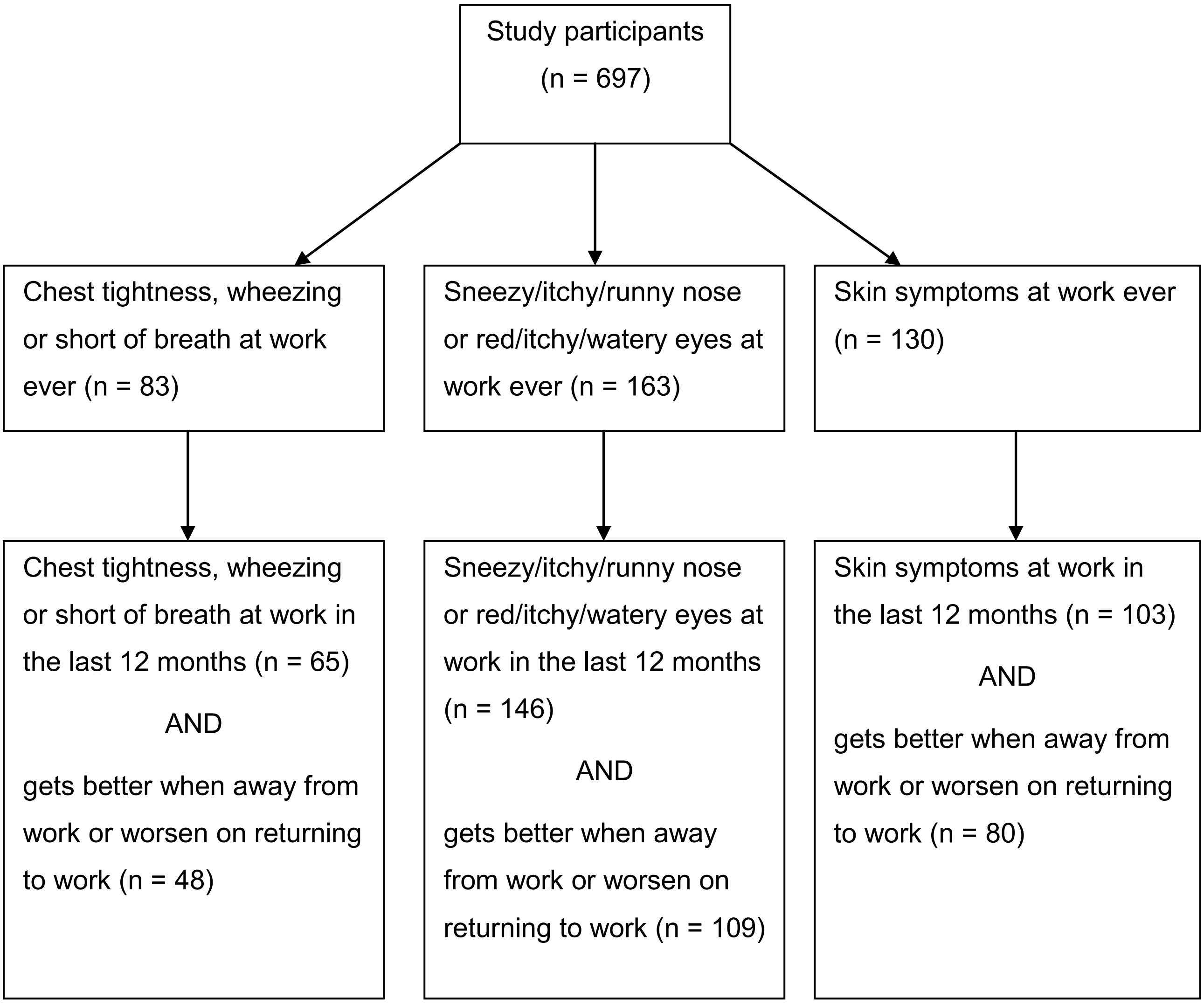
Individuals with sensitization to specific occupational allergens were identified based on sIgE ≥ 0.35 KU/L. A variable was created for sensitisation to at least one occupational allergen

(OPA, Chlorhexidine or NRL). A categorical variable for NSBH was defined as any of the following two criteria: positive methacholine challenge test (PD_{20} methacholine < 0.4 mg) or significant bronchial reversibility (≥12% and ≥ 200 ml increase in FEV_1 after administration of a bronchodilator). Two continuous indices of NSBH (continuous index of responsiveness (CIR) and dose-response slope (DRS)) were also calculated. CIR = (Post-diluent FEV_1 – FEV_1 at the last dose of methacoline) ÷ Post-diluent FEV_1 and DRS = (Post-diluent FEV_1 – FEV_1 at the last dose of methacoline) ÷ (Post-diluent FEV_1 x Last methacholine dose). CIR and DRS were all multiplied by 100 to convert them into percentages. FeNO results were interpreted as follows: low < 25ppb; elevated for values 25 - 50ppb; and high for values > 50ppb (22). In addition to the numerical variable for FeNO, two categorical variables (FeNO ≥ 25 ppb and FeNO ≥ 50 ppb) were also computed.

Further information on the host-associated risk factors was based on information obtained from the questionnaire and immunological tests (atopy). Body mass index (BMI) was calculated as weight in kilograms divided by height in metres squared. Two categorical variables were created for smoking history. One was a binary variable: ever smokers (current smokers and ex-smokers) vs never smokers. The second smoking variable was a nominal variable with three categories (current smokers, ex-smokers and never smokers). Family history of allergy was defined as a positive answer to the question "do or did any member of your family (blood relatives) ever have any kind of allergies?". Individuals with atopy were defined as those having a positive Phadiatop test. Hay fever was defined as a positive response to the question "have you ever had any nose or eye problems or allergies such as hay fever?". Childhood-onset asthma was defined as doctor-diagnosed asthma at the age of 16 years or younger. Adult-onset asthma was defined as doctor-diagnosed asthma at the age of 17 years or older. Frequency of domestic cleaning was categorised as ≥1 day/week vs <1 day/week.

Further information on the environmental risk factors was based on information obtained from the questionnaire, which had detailed information on use of cleaning agents and related tasks in the past 12 months. This included information on the duration of use per day for each cleaning agent and number of days used per week (5). For cleaning tasks, the questionnaire included information on the typical duration of each individual task, number of times per day that the task was performed and the number of days per week an individual HW performed the task in question (5). Furthermore, for each cleaning agent, frequency of use per week was calculated by multiplying duration of use per day and number of days used per week. Similarly, for each cleaning task, frequency of task performance per week was calculated by multiplying duration of the task, number of times the task was performed per day and number of days the task was performed per week. For exposure-response analyses, cleaning-related predictor variables were categorised into 3 levels (cleaning product not used; use of a cleaning product for up to 99 minutes per week and use of a cleaning product for ≥ 100 minutes per week).

Figure 3.1: Case definitions for work-related symptoms used in the study



3.4. Human subjects and ethical issues

Ethics approval was obtained from the Human Research Ethics Committee (HREC) of the University of Cape Town (HREC Ref: 212/2013), Muhimbili University of Health and Allied Sciences (MUHAS) Institutional Review Board and University of Michigan Medical School Institutional Review Board (HUM00083115). Informed written consent was sought prior to the questionnaire interview or any tests that was performed. All testing were done on a voluntary basis during working time at no direct cost to the worker. All the study participants have been provided with a written copy of their own results with interpretation. Individual results have been treated with a high degree of confidentiality. All workers with abnormal results were offered appropriate referrals for further evaluation.

3.5. Statistical analysis

All data analysis was performed using statistical software STATA version 14 (StataCorp, College Station, Texas, USA). Frequencies of categorical variables were compared between the two hospitals using Chi-squared test or Fisher's exact test where appropriate. Numerical variables were summarised using median and range, since not all variables followed a normal distribution. Scatter plots, Spearman rank correlation and unadjusted linear regression models were used to assess association between numerical variables (CIR, DRS and FeNO). Numerical variables were compared between the two hospitals using Wilcoxon sum rank test. Exposure data followed a log-normal distribution, therefore geometric mean and geometric standard deviation were used to summarise measured concentrations of aldehydes and *p*-chloroaniline (PCA). Unadjusted logistic and linear regression models were used to examine the association between measured aldehyde levels and predictor variables as well as between health outcomes (e.g. asthma-like symptoms, NSBH, FeNO, current asthma, atopic asthma, non-atopic asthma, work-related asthma) and host-related risk factors (e.g. age, gender, BMI, atopy). Multivariate logistic and linear saturated regression models adjusted for atopy, gender and smoking were used to evaluate the association between asthma-related outcomes (and other relevant clinical endpoints) and cleaning-related risk factors (specific cleaning agents and tasks). For linear regression analyses, log transformed values of DRS and FeNO were used, with geometric mean ratios and 95% confidence intervals. A negative binomial regression analysis was used for the association between asthma symptom score (a count outcome variable) and cleaning-related risk factors. Negative binomial regression models were used for this analysis instead of Poisson regression since the mean score (0.58) was lower than the standard deviation (1.11). The results of the negative binomial regression models were reported as mean ratios with 95% confidence intervals. For some regression models the regression coefficient was not calculable due to small numbers, the respective cell for that separate regression model was annotated as "not calculable" (NC) in the relevant table.

3.6. References

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CHAPTER 4

Characterisation of exposure to cleaning agents among health workers in two large tertiary hospitals in South Africa and Tanzania

ABSTRACT

Background: Over the past two decades, there has been growing evidence linking cleaning agents to adverse health effects such as rhinitis, asthma and contact dermatitis. Although cleaning agents are commonly used in workplaces and homes, health workers (HWs) are at higher risk due to a wide range of chemicals with significantly higher concentrations that are used in order to prevent healthcare associated infections. Exposure assessment for cleaning agents has been challenging partly because many cleaning agents are used simultaneously resulting in complex airborne exposures with various chemicals requiring different sampling techniques. The main objective of this study was to characterize exposures of HWs to various cleaning agents in the two tertiary academic hospitals in sub-Saharan Africa.

Methods: A cross-sectional study of HWs was conducted in two large tertiary hospitals. Systematic workplace observations and interviews with key personnel were conducted in the two hospitals using a proforma checklist. Environmental sampling for aldehydes (ortho-phthalaldehyde - OPA, glutaraldehyde and formaldehyde) was initially conducted in the South African hospital (SAH). A pilot sampling in the Tanzanian hospital (TAH) revealed very low detectable levels of OPA and glutaraldehyde and consequently full measurements were not done in this hospital. In the SAH, a total of 269 full-shift passive personal samples were collected from 164 HWs randomly selected from 17 different clinical departments. Passive sampling used TraceAir® AT580 monitors (Assay Technology, Livermore, CA). Samples were analysed for aldehydes using OSHA method 64 and NIOSH method 2016 by a South African National Accreditation System (SANAS) accredited laboratory. Biomonitoring for chlorhexidine was only conducted in the SAH since none of the HWs in the TAH used chlorhexidine. Spot urine samples from 336 participants were collected and analysed by the University of Cape Town (UCT) Clinical Pharmacology laboratory. While the study was initially set up to determine the concentration of chlorhexidine and its metabolites (*p*-chloroaniline (PCA) and 1-chloro-4-nitrobenzene), it proved feasible to develop an assay only for PCA.

Results: OPA was detectable in 6 (2%) of all samples analysed. These detectable samples were all collected in the gastrointestinal (GI) unit (GM = 0.010 ppm; range: 0.005 – 0.027). All 6 detectable samples had OPA levels higher than the newly proposed ACGIH's TLV-Ceiling Limit of 0.0001 ppm. All detectable samples were collected from HWs who used OPA. Health workers exposed to detectable OPA levels had a longer duration of OPA use (OR = 1.28; 95% CI: 1.10 – 1.50). While samples collected from nurses had the highest mean OPA exposure levels (GM = 0.014 ppm), sterilising operators had greater odds of having detectable exposures than nurses (OR = 22.43; 95% CI: 3.82 – 131.72). Formaldehyde was detectable in 103 (38%) samples (GM = 0.005 ppm; range: 0.003 –

0.027). Three (1%) samples had formaldehyde levels higher than the NIOSH recommended exposure limit (REL) of 0.016 ppm TWA but none greater than the ACGIH TLV-TWA (0.1 ppm). Formaldehyde exposure was positively associated with working in an Ear, Nose & Throat (ENT) ward (OR = 6.28; 95% CI: 1.65–23.82). Unlike OPA, job title, personal use of formaldehyde and duration of formaldehyde use were not associated with detectable formaldehyde levels. Glutaraldehyde was not detectable in the SAH. In the pilot sampling conducted in the TAH, glutaraldehyde was detectable in eight (73%) of the eleven samples collected (GM = 0.006 ppm; range: 0.001 – 0.028). Glutaraldehyde levels that were detectable were all below the ACGIH's TLV-Ceiling Limit of 0.05 ppm. PCA was detectable in 13 (4%) of the 336 urine samples collected and analysed (GM = 2.41 ng/ml range: 1.00 – 25.80).

Conclusion: Cleaning agents used in this study were similar to those used in health care settings beyond sub-Saharan Africa, but the frequency and duration of use differs depending on the setting. Workplace controls for reducing exposure to cleaning agents were deficient in both exposure contexts. The study concluded that mean detectable exposures to OPA are higher and more isolated to certain departments and are dependent on the personal use of OPA, duration of use and job title in contrast to the more widespread low-level formaldehyde exposures present throughout the hospitals. There is a need for more standardized, sensitive and validated assays for the determination of chlorhexidine and its metabolites (PCA and 1-chloro-4-nitrobenzene) in biological fluids.

4.1. INTRODUCTION

Various studies have demonstrated an association between exposure to cleaning agents and adverse health effects such as rhinitis, asthma and contact dermatitis(1). Exposure to cleaning agents is common in different workplaces as well as in domestic settings (2). Health workers (HWs) are particularly at higher risk since higher concentrations of a wide range of cleaning agents are used in order to prevent healthcare associated infections (3).

Most cleaning agents are irritants but some have both irritant and sensitising properties (4). Broad groups of potential sensitisers and irritants that are present in health care settings include medical instrument cleaning and disinfecting products (e.g. glutaraldehyde and ortho-phthalaldehyde (OPA)); fixed surfaces cleaning products (e.g. bleach); floor finishing products (stripping, waxing & buffing e.g. ethanolamine); specimen preparation products (e.g. formaldehyde); patients' skin / wound cleaning & disinfecting products (e.g. chlorhexidine and povidone iodine); hand washing / sanitising products (e.g. chlorhexidine and alcohols); aerosolised medications (e.g. pentamidine); methacrylates in dental and surgical cements; natural rubber latex products; micro-organisms and mildew(4–6).

The use of high-level disinfectants such as OPA and glutaraldehyde for heat-sensitive reusable semi-critical medical instruments such as endoscopes, bronchoscopes and respiratory therapy equipment generally follows a pre-cleaning phase to remove gross contaminants using products such as enzymatic cleaners .Glutaraldehyde has historically been used for over 40 years in health care settings not only for high-level disinfection of medical instruments but also as a fixative for electron microscopy and x-ray films. Several studies have linked glutaraldehyde and various health effects such as occupational asthma and allergic contact dermatitis (7,8). In some countries such as the United Kingdom (UK), it has been banned for this purpose (9). In 1999, the Food and Drug Administration (FDA) approved OPA to be used as a high-level disinfectant. OPA was subsequently considered a safer replacement for glutaraldehyde in some health care settings. Recently, OPA has also been reported to cause occupational asthma, contact dermatitis and anaphylaxis (10,11).

Hand hygiene and skin/wound disinfection of patients in hospital settings has been effected commonly using chlorhexidine (12–14). Since chlorhexidine is also present in several common household products such as tooth pastes, mouthwashes, ointments, eye and nose drops it is ubiquitous in the domestic setting. Chlorhexidine is well known for its sensitising and irritating properties to both the skin and airways (12–14). Previous studies have reported cases of occupational asthma and dermatitis due to chlorhexidine (12–14) and anaphylaxis among patients undergoing surgery/invasive procedures (15,16).

Exposure assessment for cleaning agents has historically posed a challenge since many cleaning agents with different ingredients are used simultaneously resulting in airborne exposures that are usually a complex mixture of various chemicals with different physico-chemical properties requiring multiple sampling techniques (17). Another challenge has been the type of product used, frequency and duration of use that all vary depending on the specific cleaning task performed (6,17). Frequently, several cleaning tasks are performed in a single room and may be repeated several times a day. Furthermore, HWs may use the same cleaning agents in different ways resulting in variable degrees of chemical exposures. It is not surprising that only a few studies have been reported on quantitative exposure assessment for cleaning agents in general, and aldehydes such as glutaraldehyde and OPA in particular.

A detailed literature search revealed studies that have focussed mainly on measurement of OPA exposures in air (18–23). The literature on development of sampling and analytical methods for the determination of OPA concentrations in air is even more scant. Uchiyama *et al* (19) published a method for the determination of OPA in air using 2,4-dinitrophenylhydrazine (DNPH)-impregnated silica cartridges and high-performance liquid chromatography (HPLC) in 2006. In 2008, Tucker reported a method for determining OPA concentration in air and two methods for measuring OPA exposure on surfaces (20). More recently, Tucker reported two partially validated methods for determination of OPA in air, one (DNPH-HPLC method) being an improvement of the previous method (22).

Despite the commercial availability of samplers, no studies were identifiable that used passive method for determining airborne OPA exposures. However, studies on passive sampling of formaldehyde and glutaraldehyde have been reported (24,25). Previous studies comparing the performance of passive and active sampling methods for formaldehyde have shown good agreement between the two assessment methods (24). However, a recent study demonstrated that passive sampling generally overestimated the formaldehyde concentrations as compared to the active method (26). Passive samplers are occasionally preferred over active methods in that they are convenient due to being small and lightweight; can be used by most individuals, often with minimal training; are less expensive; and often do not interfere with the workers' usual routine (26).

The most appropriate method for estimating exposure to chlorhexidine is to conduct biological monitoring. Environmental air sampling is considered inappropriate since chlorhexidine has a low likelihood of becoming airborne due to its very low vapour pressure. Few studies have used chlorhexidine biomonitoring to evaluate exposure (27). While some of these studies have successfully identified chlorhexidine and/or its metabolites (*p*-

chloroaniline and 1-chloro-4-nitrobenzene) in biological fluids, challenges exist in quantifying exposure (27–29).

This study was conducted to characterise exposures of HWs to major categories of cleaning agents used in two large tertiary hospitals in South Africa and Tanzania, and to identify important exposure determinants. This arose following a few incidents of anaphylaxis in patients following the use of OPA for high-level disinfection of medical instruments and some HWs reporting respiratory and skin symptoms when cleaning and disinfecting these instruments.

4.2. METHODS

4.2.1. Study population

A cross-sectional study of different categories of HWs was conducted in the two large tertiary hospitals. Following meetings with several key stakeholders and walk-through inspections by the investigators of both hospitals, specific departments were identified as potentially high-risk exposure settings for cleaning agents. Health workers in these high-risk departments used significant amounts of cleaning agents at a frequency much higher than other departments. The departments identified in the SAH included out-patient clinics, intensive care units (ICUs), operating theaters, emergency units, ENT ward, vascular radiology and the haemodialysis unit. The out-patient clinics, ICUs, operating theaters, emergency unit, Central Sterile Services Department (CSSD) and haemodialysis unit were identified in the TAH. Ethics approval was obtained from the Human Research Ethics Committee (HREC) of the University of Cape Town (HREC Ref: 212/2013), Muhimbili University of Health and Allied Sciences (MUHAS) Institutional Review Board and University of Michigan Medical School Institutional Review Board (HUM00083115).

4.2.2. General exposure assessment

A list of cleaning agents used in the two hospitals was obtained from the supply chain department of the respective hospital. Information was also obtained about the type and volume of chemicals used in the various departments of the hospital to confirm a priori high-risk departments. The most recent safety data sheets (SDS) of the cleaning products were obtained from the supply chain department and/or from suppliers/manufacturers directly. Walk-through surveys were conducted in both hospitals using a proforma checklist. The surveys were conducted by a team that included an occupational hygienist and occupational medicine specialist. The team members also conducted short interviews with the operational managers of the respective work area. During the walk-through survey, each member of the team conducted their own independent evaluation. After evaluating each specific work area (department), the team members convened for a short discussion to have a consensus decision on the relevant exposures pertaining to that department. Discrepancies in findings were resolved by consensus and the findings recorded on the checklist. The research team also communicated with the supply chain departments and nurse managers on a regular basis to ensure that any new products that were introduced during the study period also formed part of the assessment.

4.2.3. Environmental sampling of aldehydes

Measurement of aldehyde concentrations in the air was initially conducted in the SAH. A subsequent pilot sampling study in the TAH revealed very low levels of OPA and glutaraldehyde and as a result extensive environmental sampling was not done in this hospital. In the SAH, measurements of aldehydes were conducted in the 17 departments where OPA and enzymatic cleaners were used for cleaning and disinfection of medical instruments. This decision was informed by the initial walk-through survey findings. Selection of workers for OPA monitoring was limited to those on a day-shift for logistical reasons. On the earmarked sampling day, workers in each department were classified into high, medium and low/no exposure based on the results of the walk-through survey. Workers working directly with OPA were classified into a high exposure group; workers performing patient care activities were classified into a medium exposure group; and administrative workers were classified into a low/no exposure group. A random sampling strategy was employed to select workers in each stratum (high, medium, low/no exposure) for OPA air monitoring in each department. The random selection was based on using sample size calculations of the top 20%, employing a 95 percent confidence level (30). A total of 269 full-shift passive personal samples were collected from 164 HWs randomly selected from 17 different departments. Among the 164 workers selected, 70 (43%) were sampled once, 83 (50%) sampled twice and 11 (7%) were sampled thrice.

Passive sampling used TraceAir® AT580 monitors (Assay Technology, Livermore, CA). TraceAir® AT580 monitors containing a fibreglass strip treated with 2,4-dinitrophenylhydrazine (DNPH) for sampling aldehydes including OPA. The OPA reacts with DNPH in the monitor to yield an OPA-DNPH derivative. Field blanks were included in every day of passive sampling. All samples were stored at 4 degrees Celsius after collection until analysed. Analysis was conducted within four weeks of sample collection.

Samples were analysed for OPA, glutaraldehyde and formaldehyde using OSHA method 64 and NIOSH method 2016 in a South African National Accreditation System (SANAS) accredited laboratory. Two millilitres of Acetonitrile:dimethylsulfoxide (90:10) was added to extract the OPA-DNPH derivative from the monitors. The samples were left to desorb for 30 minutes, to ensure that all the analytes were dissolved in solution. Samples were analysed using an Agilent 1100 series High Performance Liquid Chromatography (HPLC) with a Variable Wavelength Detector (VWD). The column used was a Phenomonex Luna 5um C18 reversed phase. An acetate buffer was used, which contained 5 g of ammonium acetate adjusted to pH 6 with acetic acid. Acetonitrile was used as the organic solvent. The method used was 19.00 minutes in length. The flow rate was 1.5 ml/min. An isocratic mixture of buffer: acetonitrile (30:70) was used as the mobile phase. The injection volume was 20 µl, and the column temperature was controlled at 40°C. The VWD was set to 360 nm. Samples were integrated with Chemstation, where a calibration was setup beforehand. The calibration was setup by means of an external standard. A calibration stock of OPA-DNPH derivatives were obtained from Supelco. Calibration standards ranged from 1ppm to 10 ppm. A linear calibration curve was constructed and was forced through 0, with a regression of 0.99910.

4.2.4. Biomonitoring for chlorhexidine

Chlorhexidine biomonitoring was conducted in the SAH only since none of the HWs in the TAH used chlorhexidine. Urine samples for chlorhexidine biomonitoring were collected from the study participants during their health outcome assessment visit to the study venue. Spot urine samples (50 ml) were collected from 336 participants in a clean indoor toilet using a plastic container topped with a plastic cap. To avoid contamination, participants were instructed on specific precautions on washing hands before handling containers; not touching the inside of the container; collecting the midstream urine and covering the containers immediately after producing the sample. The samples were stored in the refrigerator at 4 degrees Celsius at the study venue and then transported on dry ice to the permanent storage facility on the same day of sample collection. The samples were stored at -80 degrees Celsius before being analysed at the Clinical Pharmacology laboratory at the University of Cape Town.

While the initial plan of the biomonitoring component was to develop a multiplex assay for the determination of chlorhexidine and its metabolites (*p*-chloroaniline and 1-chloro-4-nitrobenzene) in urine, due to logistical reasons it was only possible to develop a method for p-chloroaniline (PCA). The urine samples were analysed using a LC-MS/MS method developed in-house based on the detection of PCA. The samples were thawed at room temperature and extracted with 4 volumes of a 1:1 mix of 0.1% formic acid and acetonitrile, containing 62.5ng/ml *p*-bromoaniline as internal standard. The supernatant following centrifugation was transferred to a 96-well plate for LC-MS/MS analysis. Calibration standards and quality control samples were prepared by spiking PCA in blank urine to give final concentrations between 1 – 3125ng/ml. These were then extracted as described and analysed together with the patient samples to provide a standard curve from which patient PCA levels were determined. LC-MS/MS was performed on an ABSciex 4000Qtrap® mass spectrometer coupled to an Agilent 1200 Rapid Resolution HPLC system. Chromatography was achieved using a Kinetex F5 column (100 x 4.6mm, 2.6μ) using 0.1% formic acid as the aqueous mobile phase and 0.1% formic acid in acetonitrile as the organic phase. An isocratic method at 0.8ml/min was run, with a 1:1 split between the MS and waste. Carry over was avoided using a needle wash consisting water, acetonitrile, methanol, isopropanol and formic acid (30:30:30:10:0.1). Analyst 1.6 software was used for instrument control, data acquisition and analyte quantitation.

4.2.5. Statistical analyses

All data analyses were performed using statistical package STATA version 14 (StataCorp, College Station, Texas). Frequencies of categorical variables such as major categories of cleaning/disinfecting tasks, specific control measures uptake and common cleaning products used were calculated. Numerical variables were summarised using median and range, since some of the variables did not follow a normal distribution. Predictably, exposure data followed a log-normal distribution, and as a result geometric mean and geometric standard deviation were used to summarise the measured concentrations of aldehydes and *p*-chloroaniline (PCA). Univariate logistic regression analyses were used to examine the association between the outcomes of interest (aldehyde levels & PCA) and the predictor variables (e.g. job title, department).

4.3. RESULTS

4.3.1. General exposure assessment

The results of the walk-through inspections and nurse manager interviews indicate that a slightly larger number of departments were investigated in the SAH than the TAH. The major categories of cleaning-related tasks that were performed in these two hospitals included medical instruments cleaning and disinfection, fixed surfaces cleaning and disinfection, floor finishing tasks (stripping, waxing and buffing), specimen preparation, patients' skin / wound cleaning and disinfection and hand washing / sanitising (Table 4.1). Most HWs in the departments sampled used more wipes than aerosolised sprays when handling various cleaning agents.

There were no local exhaust ventilation (LEV) systems present for cleaning-related tasks in both hospitals. A greater proportion of departments in the SAH (83%) than the TAH (15%) had ceiling extractor fans. A low proportion of HWs (44% in South Africa and 23% in Tanzania) had received training on adverse health effects due to cleaning agents. None of the HWs were observed wearing an appropriate respirator (e.g. half-face respirator with vapour cartridges) when performing their cleaning and disinfecting tasks. Furthermore, both hospitals reported that there were no specific medical surveillance programs for workers working with cleaning agents.

Among the 36 nurse managers in South Africa and 13 nurse managers who were interviewed in Tanzania, 8 (22%) in the former and 7 (54%) in the latter hospital respectively reported at least one HW in their department with adverse health effects due to cleaning agents in the last 12 months. The reported number of HWs who experienced these adverse health effects was higher in the TAH, 39 (7%), when compared to 16 (2%) individuals from the SAH. While nurse managers in Tanzania reported mainly ocular symptoms, airway (nasal, throat, and chest) and skin symptoms were more commonly reported from South Africa. The cleaning agents suspected of being responsible for these adverse health effects included the most common products used for medical instrument and fixed surfaces cleaning and disinfection (Figure 4.1). While enzymatic cleaners and ortho-phthalaldehyde (OPA) were reported by nurse managers in both hospitals, chlorhexidine, a quaternary ammonium product, and a high-level disinfectant containing acetic acid, peracetic acid and hydrogen peroxide were only reported by the SAH (Figure 4.1). On the other hand, glutaraldehyde and chlorine-based products (sodium dichloroisocyanurate "Troclosene sodium" tablets and liquid hypochlorite bleach) were only reported by the TAH (Figure 4.1).

Table 4.1: Cleaning-related tasks performed, control measures uptake and health effects reported by nurse managers in the two tertiary hospitals

	Tertiary Hospital – South Africa (SAH) N (%)	Tertiary Hospital –Tanzania (TAH) N (%)
Number of health workers (HWs) in the selected departments	n = 759	n = 560
Departments investigated	n = 36	n = 13
Cleaning-related tasks performed		
Hand washing / sanitising	36 (100)	13 (100)
Fixed surfaces cleaning and disinfection	35 (97)	13 (100)
Medical instruments cleaning and disinfection	20 (56)	13 (100)
Patients' skin / wound cleaning and disinfection	31 (86)	12 (92)
Floor finishing tasks (stripping, waxing & buffing)	36 (100)	0 (0)
Specimen preparation	19 (53)	8 (62)
The manner of cleaning products use: used more sprays or more wipes		
More wipes than sprays	32 (89)	13 (100)
More sprays than wipes	3 (8)	0 (0)
Use sprays and wipes about equally	1 (3)	0 (0)
Control measures uptake		
Engineering controls present		
Extractor fans in the ceiling	30 (83)	2 (15)
Local exhaust ventilation system	0 (0)	0 (0)
Administrative controls present		
Training on adverse health effects due to cleaning agents	16 (44)	3 (23)
Availability of Standard Operating Procedures (SOP) document/s on how to use cleaning agents	13 (36)	11 (85)
Housekeeping: Chemical spill / release observed	0 (0)	1 (8)
Personal protective equipment use		
Gloves	36 (100)	13 (100)
Protective clothing (aprons, overalls)	29 (81)	3 (23)
Eye protection (goggles, face shields)	2 (6)	0 (0)
Foot protection (safety/gum boots)	1 (3)	3 (23)
Air purifying half face respirator	0 (0)	0 (0)
Medical surveillance	0 (0)	0 (0)
No. of nurse managers reporting at least one of their HCWs in their department experienced health effects due to cleaning agents in the last 12 months	8 (22%)	7 (54%)
Total number of HCWs who experienced health effects in the last 12 months as reported by their nurse managers	16 (2)	39 (7)

Figure 4.1: Cleaning agents responsible for symptoms as reported by nurse managers in the two tertiary hospitals

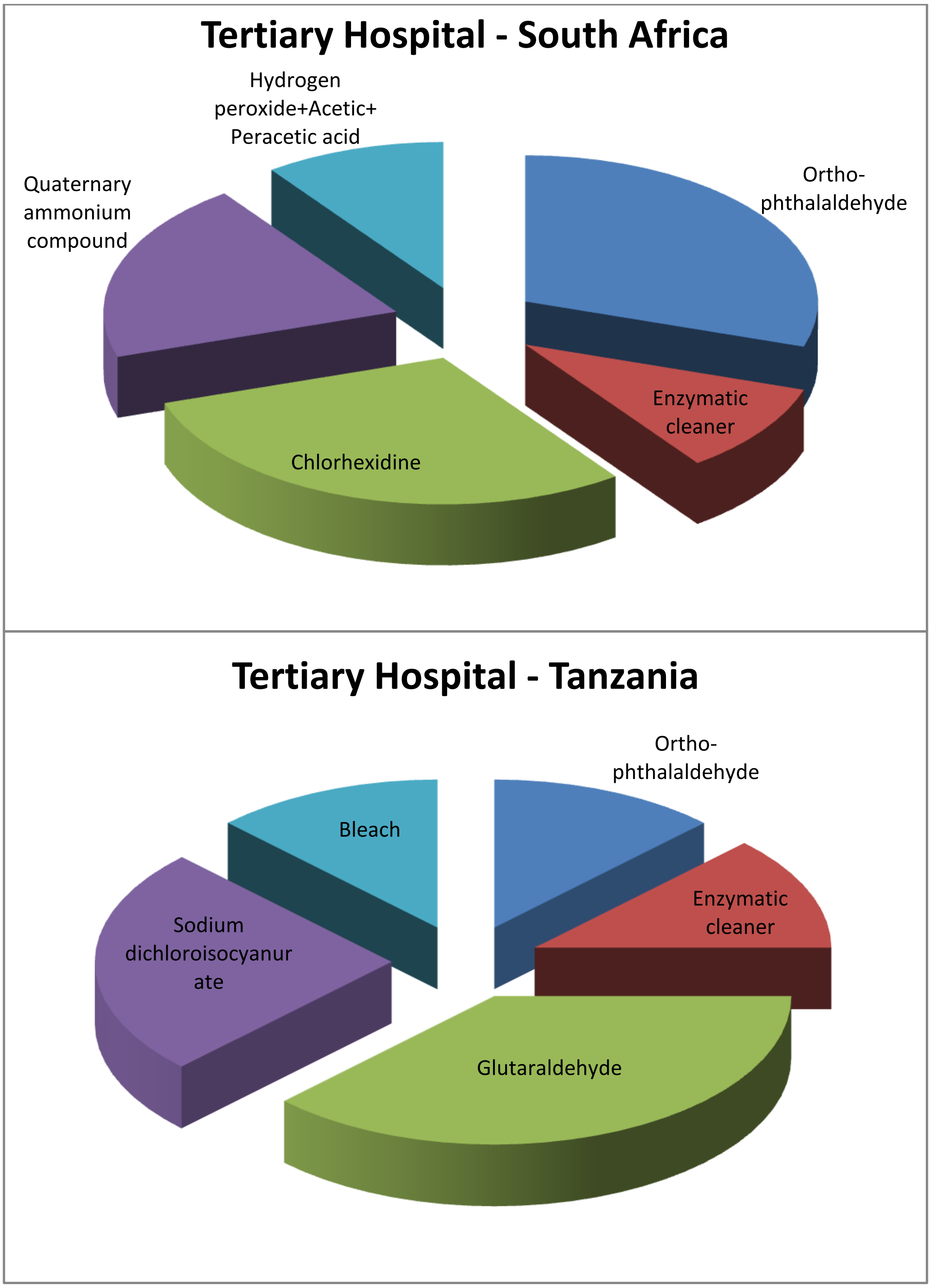

Table 4.2 presents the most common (top 5) cleaning agents used in the two tertiary hospitals. The most common high-level disinfectant used for heat-sensitive medical instruments in South Africa was OPA (36%), followed by hydrogen peroxide (14%). Whilst OPA (23%) was also used in Tanzania, glutaraldehyde (31%) was more commonly used. Glutaraldehyde was not used for medical instruments cleaning and disinfection in the SAH. Enzymatic cleaners were also used in both hospitals for cleaning medical instruments prior to disinfection. In South Africa, enzymatic cleaners (median: 300 minutes/week; range: 8 – 1800 minutes/week) and alcohols (median: 300 minutes/week; range: 2 – 600 minutes/week) had the longest average duration of use for medical instruments cleaning and disinfection, while in Tanzania, an all-purpose cleaner (median: 368 minutes/week; range: 95 – 1500 minutes/week) and chlorine-based bleach products (median: 248 minutes/week; range: 70 – 490 minutes/week) were used for the longest average duration (Table 4.3A). Out-patient clinics and operating theatres in both hospitals used most of the products for medical instruments cleaning and disinfection.

Bleach was the most common product used for fixed surfaces cleaning and disinfection in both hospitals (Table 4.2). Bleach had also the longest average duration of use for fixed surfaces cleaning and disinfection in both hospitals (South Africa = median: 1020 minutes/week; range: 140 – 4200 minutes/week and Tanzania = median: 1200 minutes/week; range: 900 – 1800 minutes/week). Intensive care units (median: 2100 minutes/week; range: 140 – 2520 minutes/week) in South Africa and out-patient clinics (median: 1440 minutes/week; range: 900 – 1800 minutes/week) in Tanzania had the longest duration of bleach use for fixed surfaces cleaning and disinfection (Table 4.3B). Other common products used for fixed surfaces cleaning and disinfection were ammonia (92%), alcohols (86%) and a dishwashing liquid (81%) in SAH and an all-purpose cleaner (100%) in the TAH.

Floor finishing tasks were not performed by HWs in the TAH. While floor strippers and waxes were used only once a year in each department in the SAH, buff sprays (diluted floor waxes) were used more frequently (median: 2 times/week; range: 1 – 5 times/week). The haemodialysis unit had the longest average duration use of buff sprays (median: 360 minutes/week; range: 360 – 360 minutes/week) compared to other departments.

Formalin (10%) solution was commonly used in both hospitals for specimen preparation (tissue fixation). Vascular radiology (median: 70 minutes/week; range: 70 – 70 minutes/week) and operating theatres (median: 49 minutes/week; range: 2 – 100 minutes/week) in the SAH as well as operating theatres (median: 8 minutes/week; range: 2 – 15 minutes/week) in Tanzania had the longest duration of formalin use for tissue fixation (Table 4.3C). Health workers in the SAH reported a higher duration of formalin use (median:

33 minutes/week; range: 2 – 300 minutes/week) than their Tanzanian counterparts (median: 6 minutes/week; range: 2 – 50 minutes/week). The other common product used for specimen preparation in the South African hospital was an alcohol-based spray for cytological specimens.

Alcohols and povidone iodine were used commonly in both hospitals for disinfection of patients' surfaces before a surgical or instrument procedure or for wound care. Notably, chlorhexidine containing products were commonly used (61%) in the SAH for patients' surfaces disinfection and wound care but not in Tanzania. HWs in the emergency units of both hospitals had the longest average duration of alcohol usage for disinfection of patients' surfaces and wound care compared to other departments. The longest duration of povidone iodine use was recorded in the operating theatres (median: 222 minutes/week; range: 100 – 350 minutes/week) in South Africa while in Tanzania, intensive care units (median: 150 minutes/week; range: 150 – 150 minutes/week) and operating theatres (median: 125 minutes/week; range: 50 – 300 minutes/week) had the longest duration of povidone iodine use.

Liquid products for hand washing and/or sanitising were used quite commonly by HWs in all the departments studied in both hospitals although South African HWs reported much higher frequency of use. Chlorhexidine containing products (100%), liquid hand soap (92%) and alcohol sanitisers (75%) were the most common hand products used in South Africa (Table 4.2). In Tanzania, a diluted all-purpose cleaner (92%) was the most commonly used hand product, followed by an alcohol sanitiser (62%). Alcohol sanitisers (median: 60 times/day; range: 10 – 140 times/day), followed by chlorhexidine containing products (median: 55 times/day; range: 3 – 120 times/day) were the most frequently used hand products in South Africa. In Tanzania, a diluted all-purpose cleaner (median: 30 times/day; range: 10 – 40 times/day) followed by an alcohol sanitiser (median: 23 times/day; range: 5 – 35 times/day) were the most frequently used products for hand washing/sanitising.

Table 4.2: The most common cleaning products used in the two tertiary hospitals

	Tertiary Hospital – South Africa N = 36		Tertiary Hospital –Tanzania N = 13	
Medical instruments cleaning & disinfection	**n = 20**	**n (%)**	**n = 13**	**n (%)**
	Enzymatic cleaners	15 (42)	Bleach	10 (77)
	Ortho-phthalaldehyde	13 (36)	All-purpose cleaner	10 (77)
	Alcohols	7 (19)	Enzymatic cleaners	5 (39)
	Chlorhexidine	6 (17)	Glutaraldehyde	4 (31)
	Hydrogen peroxide	5 (14)	Ortho-phthalaldehyde	3 (23)
Fixed surfaces cleaning & disinfection	**n = 35**	**n (%)**	**n = 13**	**n (%)**
	Bleach	34 (94)	Bleach	13 (100)
	Ammonia	33 (92)	All-purpose cleaner	13 (100)
	Alcohols	31 (86)	Glass cleaner	7 (54)
	Dishwashing liquid	29 (81)	Floor cleaner	2 (15)
	Air freshener	21 (58)		
Floor finishing tasks (stripping, waxing & buffing)	**n = 36**	**n (%)**	**n = 0**	**n (%)**
	Floor stripper	36 (100)		
	Floor wax	36 (100)		
Specimen preparation	**n = 19**	**n (%)**	**n = 8**	**n (%)**
	Formalin 10% solution	18 (50)	Formalin 10% solution	8 (62)
	Cytological fixative spray	14 (39)		
	Alcohol solution	3 (8)		
	Glutaraldehyde	1 (3)		
Patients' skin / wound cleaning & disinfection	**n = 31**	**n (%)**	**n = 12**	**n (%)**
	Alcohols	27 (75)	Alcohols	12 (92)
	Chlorhexidine	22 (61)	Povidone iodine	11 (85)
	Povidone iodine	15 (42)	Chloroxylenol	4 (31)
	Ether	6 (17)	Hydrogen peroxide mouthwash	1 (8)
	Acetone	2 (6)		
Hand washing / sanitising	**n = 36**	**n (%)**	**n =12**	**n (%)**
	Chlorhexidine	36 (100)	All-purpose cleaner (diluted)	12 (92)
	Liquid hand soap	33 (92)	Alcohol sanitiser	8 (62)
	Alcohol sanitiser	27 (75)	Hand wash liquid soap	1 (8)
	Povidone iodine	6 (17)		

N = number of departments assessed; n = number of departments conducting the task/s

Table 4.3A: Duration of cleaning products use for medical instrument cleaning and disinfection classified by department in the two tertiary hospitals

Medical instruments cleaning and disinfection

Tertiary Hospital – South Africa (N = 36)

Department	**N**	**Enzymatic**		**OPA**		**Alcohol**		**Chlorhexidine**		**Hydrogen peroxide**	
		n	Mins /week median (range)	n	Mins /week median (range)	n	Mins /week median (range)	n	Mins /week median (range)	n	Mins /week median (range)
Out-patient clinics (n=9)	9	6	1050 (150-1800)	6	720 (60–1800)	4	300 (30-600)	3	300 (150-1200)	2	163 (25-300)
Intensive care units (n=9)	0	0		0		0		0		0	
Operating theatres (n=11)	7	6	165 (8-400)	4	15 (5–150)	2	301 (2-600)	1	400 (400-400)	1	400 (400-400)
Emergency units (n=3)	1	1	35 (35-35)	1	35 (35-35)	1	70 (70-70)	1	70 (70-70)	0	
ENT ward (n=1)	1	1	50 (50-50)	1	30 (30–30)	0		0		1	75 (75-75)
Vascular radiology (n=1)	1	1	210 (210-210)	1	105 (105–105)	0		1	210 (210-210)	1	210 (210-210)
Haemodialysis (n=2)	1	0		0		0		0		0	
Overall (n=36)	20	15	300 (8-1800)	13	75 (5–1800)	7	300 (2-600)	6	255 (70-1200)	5	210 (25-400)

Tertiary Hospital –Tanzania (N = 13)

Department	**N**	**Bleach**		**All-purpose cleaner**		**Enzymatic**		**Glutaraldehyde**		**OPA**	
		n	Mins /week median (range)	n	Mins /week median (range)	n	Mins /week median (range)	n	Mins /week median (range)	n	Mins /week median (range)
Out-patient clinics (n=3)	3	1	95 (95 – 95)	3	630 (95 – 1500)	2	430 (90 – 770)	2	420 (90 – 750)	0	
Intensive care units (n=3)	3	3	330 (70 – 490)	3	320 (145 – 490)	0		0		0	
Operating theatres (n=4)	4	4	248 (110 – 280)	2	433 (215 – 650)	3	215 (70 – 270)	2	35 (20 – 50)	2	265 (30 – 500)
Emergency units (n=1)	1	1	415 (415 – 415)	1	415 (415 – 415)	0		0		1	100 (100 – 100)
CSSD (n=1)	1	1	70 (70 – 70)	1	145 (145 – 145)	0		0		0	
Haemodialysis (n=1)	1	0		0		0		0		0	
Overall (n=13)	13	10	248 (70 – 490)	10	368 (95 – 1500)	5	215 (70 – 770)	4	70 (20 – 750)	3	100 (30 – 500)

n = number of departments using the product; N = number of departments doing the task

Table 4.3B: Duration of cleaning products use for fixed surfaces cleaning and disinfection classified by department in the two tertiary hospitals

	Fixed surfaces cleaning and disinfection																		
	Tertiary Hospital – South Africa (N = 36)									Tertiary Hospital –Tanzania (N = 13)									
Department	N	**Bleach**		**Ammonia**		**Alcohol**		**Dishwashing liquid**		**Department**	**N**	**Bleach**		**All-purpose cleaner**		**Glass cleaner**		**Floor cleaner**	
		n	Mins /week median (range)	n	Mins /week median (range)	n	Mins /week median (range)	n	Mins /week median (range)			n	Mins /week median (range)	n	Mins /week median (range)	n	Mins /week median (range)	n	Mins /week median (range)
Out-patient clinics (n=9)	9	9	600 (600-1260)	9	600 (210-1200)	9	420 (90-1800)	5	1260 (900-1800)	**Out-patient clinics** (n=3)	3	3	1440 (900 – 1800)	3	1440 (900 – 1800)	2	125 (100 – 150)	0	
Intensive care units (n=9)	9	9	2100 (140-2520)	8	420 (140-2520)	9	420 (210-2520)	9	105 (70-2100)	**Intensive care units** (n=3)	3	3	1200 (900 – 1200)	3	1200 (900 – 1200)	3	150 (30 – 150)	2	120 (120 – 120)
Operating theatres (n=11)	10	10	1200 (180-4200)	10	2010 (50-2520)	8	220 (50-420)	9	4200 (50-4200)	**Operating theatres** (n=4)	4	4	900 (900 – 900)	4	750 (150 – 900)	1	150 (150 – 150)	0	
Emergency units (n=3)	3	3	420 (210-3360)	3	420 (210-420)	3	210 (210-210)	3	70 (70-420)	**Emergency units** (n=1)	1	1	1200 (1200 – 1200)	1	1200 (1200 – 1200)	0		0	
ENT ward (n=1)	1	1	420 (420-420)	1	1260 (1260-1260)	0		1	1260 (1260-1260)										
Vascular radiology (n=1)	1	1	210 (210-210)	1	210 (210-210)	1	210 (210-210)	1	70 (70-70)	**CSSD** (n=1)	1	1	900 (900 – 900)	1	900 (900 – 900)	0		0	
Haemodialysis (n=2)	1	1	840 (840-840)	1	840 (840-840)	1	420 (420-420)	1	840 (840-840)	**Haemodialysis** (n=1)	1	1	1200 (1200 – 1200)	1	1200 (1200 – 1200)	1	30 (30 – 30)	0	
Overall (n=36)	34	34	1020 (140-4200)	33	600 (50-2520)	31	300 (50–2520)	29	840 (50-4200)	**Overall** (n=13)	13	13	1200 (900 – 1800)	13	900 (150 – 1800)	7	150 (30 – 150)	2	120 (120 – 120)

n = number of departments using the product; N = number of departments doing the task

Table 4.3C: Duration of cleaning products use for other tasks classified by department in the two tertiary hospitals

	Tertiary Hospital – South Africa (N = 36)													Tertiary Hospital –Tanzania (N = 13)								
Department	**Floor finishing products**		**Products for specimen preparation**					**Hand sanitisers and hand washing products**						**Department**	**Products for specimen preparation**		**Hand sanitisers and hand washing products**					
	Buff sprays (diluted floor waxes)			**Formalin 10% solution**		**Cytological fixative spray**		**Chlorhexidine**		**Liquid hand soap**		**Alcohol sanitiser**			**Formalin 10% solution**		**All-purpose cleaner (diluted)**		**Alcohol sanitiser**		**Hand wash liquid soap**	
	n	Mins / week median (range)	n	n	Mins / week median (range)	n	Mins / week median (range)	n	Times / day median (range)	n	Times / day median (range)	n	Times / day median (range)		n	Mins / week median (range)	n	Times / day median (range)	n	Times / day median (range)	n	Times / day median (range)
Out-patient clinics (n=9)	9	150 (120 – 150)	8	7	15 (3–300)	7	25 (2–300)	9	40 (10 – 80)	9	40 (2–100)	8	50 (10–80)	**Out-patient clinics** (n=3)	3	6 (6 – 50)	2	20 (10 – 25)	0		1	10 (10 – 10)
Intensive care units (n=9)	9	240 (120 – 900)	1	1	15 (15–15)	1	2 (2–2)	9	80 (50 – 120)	9	15 (6–50)	7	100(75–140)	**Intensive care units** (n=3)	0		3	30 (30 – 35)	3	30 (30 – 35)	0	
Operating theatres (n=11)	11	240 (60 – 240)	8	8	49 (2–100)	4	49 (40–100)	11	30 (3 – 100)	10	10 (5–30)	6	47 (30–100)	**Operating theatres** (n=4)	4	8 (2 – 15)	4	30 (20 – 30)	2	8 (5 – 10)	0	
Emergency units (n=3)	3	180 (120 – 450)	1	1	7 (7–7)	1	7 (7–7)	3	70 (20 – 100)	2	12 (8–15)	3	70 (35–115)	**Emergency units** (n=1)	0		1	30 (30 – 30)	1	20 (20 – 20)	0	
ENT ward (n=1)	0		0	0		0		1	50 (50 – 50)	1	100 (100–100)	1	50 (50–50)									
Vascular radiology (n=1)	1	30 (30 – 30)	1	1	70 (70–70)	1	10 (10–10)	1	30 (30 – 30)	1	20 (20–20)	1	30 (30–30)	**CSSD** (n=1)	0		1	30 (30 – 30)	1	10 (10 – 10)	0	
Haemodialysis (n=2)	2	360 (360 – 360)	0	0		0		2	45 (10 – 80)	1	10 (10–10)	1	10 (10–10)	**Haemodialysis** (n=1)	1	3 (3 – 3)	1	40 (40 – 40)	1	25 (25 – 25)	0	
Overall (n=36)	35	150 (30 – 900)	19	18	33 (2–300)	14	28 (2–300)	36	55 (3 – 120)	33	15 (2–100)	27	60 (10–140)	**Overall** (n=13)	8	6 (2 – 50)	12	30 (10 – 40)	8	23 (5 – 35)	1	10 (10 – 10)

n = number of departments using the product/s; N = number of departments doing the task

Floor strippers and waxes were used only once a year in each department at GSH. Floor strippers and waxes were not used at MNH

Table 4.3D: Duration of cleaning products use for patients' skin / wound cleaning and disinfection classified by department in the two tertiary hospitals

	Patients' skin / wound cleaning and disinfection																
	Tertiary Hospital – South Africa (N = 36)									Tertiary Hospital –Tanzania (N = 13)							
Department	N	**Alcohols**		**Chlorhexidine**		**Povidone iodine**		**Ether**		**Department**	**N**	**Alcohols**		**Povidone iodine**		**Chloroxylenol**	
		n	Mins /week median (range)	n	Mins /week median (range)	n	Mins /week median (range)	n	Mins /week median (range)			n	Mins /week median (range)	n	Mins /week median (range)	n	Mins /week median (range)
Out-patient clinics (n=9)	7	5	202 (15-1000)	3	202 (15–700)	6	114 (12-200)	1	12 (12-12)	**Out-patient clinics** (n=3)	3	3	150 (50-180)	2	105 (60-150)	0	
Intensive care units (n=9)	9	9	140 (56-735)	9	84 (15-455)	0		3	126 (70-280)	**Intensive care units** (n=3)	3	3	150 (150-150)	3	150 (150-150)	1	75 (75-75)
Operating theatres (n=11)	10	9	150 (7-500)	8	132 (3-300)	6	222 (100-350)	2	50 (50-50)	**Operating theatres** (n=4)	4	4	100 (25-300)	4	125 (50-300)	3	150 (75-300)
Emergency units (n=3)	3	3	525 (56-560)	1	315 (315-315)	3	56 (2-156)	0		**Emergency units** (n=1)	1	1	300 (300-300)	1	75 (75-75)	0	
ENT ward (n=1)	0	0		0		0		0									
Vascular radiology (n=1)	1	0		0		0		0		**CSSD** (n=1)	0	0		0		0	
Haemodialysis (n=2)	1	1	200 (200-200)	1	200 (200-200)	0		0		**Haemodialysis** (n=1)	1	1	30 (30-30)	1	30 (30-30)	0	
Overall (n=36)	31	27	200 (7-1000)	22	130 (3 – 700)	15	144 (2-350)	6	60 (12-280)	**Overall** (n=13)	12	12	150 (25-300)	11	150 (30-300)	4	113 (75-300)

n = number of departments using the product; N = number of departments doing the task

4.3.2. Environmental sampling for aldehydes

OPA was detectable in 6 (2%) of all samples analysed (Table 4.4). These detectable samples were all collected in the gastrointestinal (GI) unit (GM = 0.010 ppm; range: 0.005 – 0.027) of SAH. All the 6 detectable samples had OPA levels higher than the newly proposed ACGIH's TLV-Ceiling Limit of 0.0001 ppm (31). All detectable samples were collected from HWs who used OPA. While samples collected from nurses had the highest mean OPA exposure levels (GM = 0.014 ppm) (Table 4.5), sterilising operators had greater odds of having detectable exposures than nurses (OR = 22.43; 95% CI: 3.82 – 131.72). Health workers exposed to detectable OPA levels had an increased odds of having a longer duration of OPA use (OR = 1.28; 95% CI: 1.10 – 1.50) (Table 4.6). Overall, department, job title, personal use of OPA and duration of OPA use were the important predictors of detectable OPA exposures (Table 4.6).

Formaldehyde, on the other hand was detectable in a greater proportion (38%) of the 269 collected samples (GM = 0.005 ppm; range: 0.003 – 0.027). Three (1%) samples had formaldehyde levels higher than the NIOSH recommended exposure limit (REL) of 0.016 ppm TWA, but none greater than the ACGIH TLV-TWA (0.1 ppm). Formaldehyde exposure was positively associated with working in an Ear, Nose & Throat (ENT) ward (OR = 6.28; 95% CI: 1.65–23.82) and a longer duration of passive sampling (OR = 1.01; 95% CI: 1.00 – 1.01). Unlike OPA, job title, personal use of formaldehyde and duration of formaldehyde use were not associated with detectable formaldehyde levels (Table 4.7).

Glutaraldehyde was not detectable in the SAH. In the pilot sampling that was conducted in the TAH, glutaraldehyde was detectable in eight (73%) of the eleven samples collected (GM = 0.006 ppm; range: 0.001 – 0.028). Glutaraldehyde levels detectable in this study were all below the ACGIH's TLV-Ceiling Limit of 0.05 ppm.

Table 4.4: Personal aldehyde exposure levels classified by department in a South African tertiary hospital

Department	K	N	**Formaldehyde** (ppm)					**Ortho-phthalaldehyde** (ppm)				
			Detectable samples					Detectable samples				
			n (%)	AM	GM	GSD	Range	n (%)	AM	GM	GSD	Range
Out-patient clinics	75	147	51 (35)	0.005	0.004	1.282	0.003 – 0.008	6 (4)	0.013	0.010	2.085	0.005 – 0.027
Intensive care units	0	0										
Operating theatres	59	79	25 (32)	0.005	0.005	1.582	0.003 – 0.020					
Emergency units	3	3	3 (100)	0.004	0.004	1.292	0.003 – 0.005		All < LOD			
ENT ward	7	13	10 (77)	0.007	0.006	1.818	0.004 – 0.027					
Vascular radiology	20	27	14 (52)	0.006	0.005	1.690	0.003 – 0.018					
Haemodialysis	0	0										
Overall	164	269	103 (38)	0.005	0.005	1.484	0.003 – 0.027	6 (2)	0.013	0.010	2.085	0.005 – 0.027

K = no. of workers sampled; N = no. of samples collected; n = no. of samples with detectable levels; AM=arithmetic mean; GM=geometric mean; GSD=geometric standard deviation; LOD = limit of detection; LOD for formaldehyde = 0.10µg; LOD for OPA = 0.01µg; ENT = ear, nose and throat; ppm = parts per million

Table 4.5: Personal aldehyde exposure levels classified by job title in a South African tertiary hospital

Job title	K	N	**Formaldehyde** (ppm)					**Ortho-phthalaldehyde** (ppm)				
			Detectable samples					**Detectable samples**				
			n (%)	AM	GM	GSD	Range	n (%)	AM	GM	GSD	Range
Nurses (RN, EN & NA)	94	160	60 (38)	0.005	0.005	1.463	0.003 – 0.020	3 (2)	0.018	0.014	2.638	0.005 – 0.027
Sterilising operators	6	10	3 (30)	0.004	0.004	1.181	0.003 – 0.004	3 (30)	0.007	0.007	1.408	0.005 – 0.009
Doctors	5	7	4 (57)	0.010	0.007	2.478	0.004 – 0.027		All < LOD			
Cleaners	19	32	10 (31)	0.004	0.004	1.283	0.003 – 0.007					
Others#	40	60	26 (43)	0.005	0.005	1.434	0.003 – 0.018					
Overall	164	269	103 (38)	0.005	0.005	1.484	0.003 – 0.027	6 (2)	0.013	0.010	2.141	0.005 – 0.027

K = no. of workers sampled; N = no. of samples collected; n = no. of samples with detectable levels; RN = Registered nurse; EN = Enrolled nurse; NA = Nurse assistant AM=arithmetic mean; GM=geometric mean; GSD=geometric standard deviation; #Others= clerks, porters, technologists, ECG technicians & radiographers; LOD = limit of detection; LOD for formaldehyde = 0.10µg; LOD for OPA = 0.01µg;ppm = parts per million

Table 4.6: Predictors of personal ortho-phthalaldehyde (OPA) exposure levels in a South African tertiary hospital

	Ortho-phthalaldehyde (ppm)
	Detectable vs Undetectable OR (95% CI)
Duration of sampling	0.99 (0.98 - 1.00)
Job title*# Sterilising operators (n = 6) vs Nurses (n = 94)	**22.43 (3.82 - 131.72)****
Personal OPA use##	NC
Personal OPA use duration (minutes / day)	**1.28 (1.10 - 1.50)****

**p-value < 0.01; OR = odds ratio; NC = not calculable; CI = confidence interval; ppm = parts per million; *Reference group = nurses; #OPA levels were undetectable for the remaining job titles (Cleaners, Clerks, Porters, Radiographers, Technologists, ECG Technicians and Doctors); ##All workers with detectable OPA levels used OPA; LOD for OPA = 0.01µg; n = no. of workers sampled

Table 4.7: Predictors of personal formaldehyde exposure levels in a South African tertiary hospital

	Formaldehyde (ppm)
	Detectable vs Undetectable OR (95% CI)
Duration of sampling (minutes)	**1.01 (1.00 - 1.01)****
Department#	
Operating theatres	0.89 (0.50 – 1.59)
Emergency units	NC€
ENT ward	**6.28 (1.65 – 23.82)****
Vascular radiology	2.03 (0.89 – 4.64)
Job title##	
Nurses (RN, EN & NA)	1.40 (0.35 – 5.62)
Doctors	3.11 (0.41 – 23.39)
Cleaners	1.06 (0.23– 4.97)
Others (Clerks, Porters, Radiographers, Technologists & ECG Technicians)	1.84 (0.43 – 7.81)
Personal formalin use	1.54 (0.53- 4.48)
Personal formalin use duration (minutes / day)	0.80 (0.54- 1.20)
Formalin used in the department	0.73 (0.43 - 1.24)

**p-value < 0.01; NC = Not calculable; OR = Odds ratio; CI = Confidence interval; ECG = Electrocardiogram; ppm = parts per million; ENT = ear, nose and throat; RN = registered nurse; EN = enrolled nurse; NA = nurse assistant; #Reference group =Out-patient clinics; ##Reference group = Sterilising operators; €All sampled workers had detectable formaldehyde levels; LOD for formaldehyde = 0.10µg

4.3.3. Biomonitoring for chlorhexidine

PCA, a metabolite of chlorhexidine, was detectable in 13 (4%) of all 336 urine samples that were analysed (GM = 2.41 ng/ml range: 1.00 – 25.80), which did not appear to differ by department or job type (Tables 4.8 and 4.9). The highest concentration (25.80 ng/ml) measured was obtained from a technician in the Haemodialysis unit and a registered nurse (6.47 ng/ml) in the Vascular Radiology department

Table 4.8: *p*-Chloroaniline urine levels classified by department in a South African tertiary hospital

Department	N	***p*-Chloroaniline** (ng/ml)				
		Detectable samples				
		n (%)	AM	GM	GSD	Range
Out-patient clinics	52	0 (0)	All < LOQ			
Intensive care units	106	5 (5)	1.37	1.33	1.30	1.00 – 1.94
Operating theatres	89	4 (5)	2.88	2.32	2.18	1.08 – 5.42
Emergency units	34	2 (6)	2.13	2.13	1.08	2.01 – 2.25
ENT ward	12	0 (0)	All < LOQ			
Vascular radiology	25	1 (4)	6.47	6.47	NC	6.47 – 6.47
Haemodialysis	18	1 (6)	25.80	25.80	NC	25.80 – 25.80
Overall	336	13 (4)	4.22	2.41	2.55	1.00 – 25.80

N = no. of samples collected; n = no. of samples with detectable levels; NC = Not calculable;
AM=arithmetic mean; GM=geometric mean; GSD=geometric standard deviation; LOQ = limit of quantification;
ENT = ear, nose and throat; ng/ml = nanograms/millilitre; LOQ for *p*-chloroaniline = 1 ng/ml

Table 4.9: *p*-Chloroaniline urine levels classified by job title in a South African tertiary hospital

Job title	N	***p*-Chloroaniline** (ng/ml)				
		Detectable samples				
		n (%)	AM	GM	GSD	Range
Nurses	234	10 (4)	2.63	2.11	1.97	1.00 – 6.47
Registered nurses	129	6 (5)	3.32	2.67	2.11	1.11 – 6.47
Enrolled nurses	46	2 (4)	1.67	1.56	1.68	1.08 – 2.25
Nurse assistants	59	2 (3)	1.51	1.42	1.64	1.00 – 2.01
Cleaners	44	2 (4)	1.42	1.42	1.08	1.34 – 1.50
Technicians	32	1 (3)	25.80	25.80	NC	25.80 – 25.80
Clerks	12	0 (0)	All < LOQ			
Porters	14	0 (0)				
Overall	336	13 (4)	4.22	2.41	2.55	1.00 – 25.80

N = no. of samples collected; n = no. of samples with detectable levels; RN = Registered nurse; EN = Enrolled nurse; NA = Nurse assistant;
AM=arithmetic mean; GM=geometric mean; GSD=geometric standard deviation; LOQ = limit of quantification; ng/ml = nanograms/millilitre; NC = Not calculable; LOQ for *p*-chloroaniline = 1 ng/ml

4.4. DISCUSSION

The results of this study demonstrate that a wide variety of agents are used for cleaning and disinfection in hospital settings located in Southern Africa. Although, cleaning agents used in this study were similar to those used in health care settings elsewhere, the frequency and duration of use differed. The mean detectable exposures to OPA were higher and more isolated to certain departments and were dependent on the personal use of OPA, duration of use and job title in contrast to the more widespread low-level formaldehyde exposures present throughout the hospitals. The study also highlighted that workplace controls for reducing exposure to cleaning agents were not adequate.

The most common high-level disinfectant used in the South African (SAH) was OPA. However, in the Tanzanian hospital (TAH), glutaraldehyde was more commonly used. Formaldehyde was not used for medical instrument cleaning and disinfection in both the SAH and the TAH. This is contrary to other hospital settings as in the USA and Saudi Arabia where formaldehyde continues to be used for medical instrument cleaning and disinfection, although at a lower frequency compared to other agents (32,33).

Quaternary ammonium compounds were not used in the TAH but were used at a much lower frequency (8%) in the SAH for medical instrument disinfection. In contrast, quaternary ammonium compounds were the leading cleaning agents used by my most nurses (93%) for cleaning and disinfection of medical instruments in Saudi Arabia (32). Quaternary ammonium compounds are also commonly used for cleaning and disinfection in health care settings in other industrialised countries, including USA and Europe (34–36).

Products that are used for cleaning medical instruments prior to disinfection such as enzymatic cleaners and chlorine-based bleach products were used for the longest duration compared to the high-level disinfectants. This finding is consistent with workplace observations conducted during the exposure assessment evaluation in that HWs spent more time cleaning medical instruments to remove gross biological contaminants than handling or working with high-level disinfectants.

In this study, chlorine-based bleach was the most common product, which also had the longest average duration of use for fixed surface cleaning and disinfection in both hospitals. In the SAH, HWs used both the liquid bleach and the granules (which were dissolved in water before use). Liquid bleach and sodium dichloroisocyanurate (Troclosene sodium) effervescent tablets were used in the TAH. Bleach is commonly used for cleaning and disinfection in both the domestic and hospital settings (33,37). Interestingly, bleach was not used in 6 hospitals studied in a US-based study among HWs responsible for cleaning and disinfection demonstrating the feasibility of substituting bleach with other cleaning products (6).

In this study, alcohols were commonly used for several cleaning tasks such as medical instruments cleaning and disinfection, fixed surfaces cleaning and disinfection, specimen preparation, patients' skin / wound cleaning and disinfection and hand washing / sanitising. These findings corroborate results of previous studies conducted globally that reported alcohols as one of the most common ingredients of cleaning products used in hospital settings (6,34,36).

Workplace controls for reducing exposure to cleaning agents were either lacking or present in only a few areas of both hospitals. Notably, there were no local exhaust ventilation (LEV) systems in any of the work areas. Whilst extractor fans were present in a few areas, their effectiveness/efficiency was not assessed. Furthermore, use of appropriate personal protective equipment was very low, and none of the workers used appropriate respirators nor was appropriate protective clothing to prevent dermal exposure. It was also noted that there was no medical surveillance program specific for HWs exposed to cleaning agents. Control of workplace exposures to cleaning agents has posed challenges not only in lower income health care settings but also in the industrialised world (38). A study of 5 hospitals in Canada reported lack of LEV in all the locations that glutaraldehyde was used (38). It may be a challenge to establish engineering controls (e.g. LEV) for some cleaning tasks that are conducted in numerous hospital locations such as fixed surfaces cleaning. However, it is possible to install LEV systems in areas where specific tasks are performed such as medical instrument cleaning and disinfection, decanting or dilution of cleaning products. A Saudi Arabian study among nurses responsible for medical instrument cleaning and disinfection reported promising findings as most nurses (96.4%) worked in areas with negative ventilation (32).

In this study, OPA levels (GM = 0.010 ppm) were, on average, 10-fold higher than in similar settings elsewhere (11,18,21,23,39,40). The highest OPA concentration measured in this study was 0.027 ppm. The mean OPA concentration reported in a previous Italian study among HWs in endoscopy units was 0.0015 ppm (39). A Japanese study that conducted air measurements for OPA in an endoscopy unit reported OPA concentrations in the range of 0.0006 – 0.002 ppm (40). The highest concentration (0.002 ppm) was found when a bucket containing OPA was left open without a lid while an endoscope washing machine was operating (40). A later Japanese study conducted air measurements for OPA in 9 manual disinfection rooms and in 8 rooms using automatic endoscope washers (21). The TWA concentration of OPA in this Japanese study was higher in the manual group (median = 0.0007 ppm) than in the automatic endoscopic washer group (median = 0.0003 ppm) (21). A more recent US study conducted among 8 health facilities, confirmed that the average OPA concentrations were higher (GM = 0.00006 ppm) in the group of workers from the departments using OPA than in the comparison group (GM = 0.00003 ppm) where OPA was not used, although these levels were lower than the OPA exposures reported in the current study (23).

There are several reasons that could explain the higher OPA concentrations reported in the current study. The first possible reason is the lack of adequate engineering methods for controlling airborne exposures to OPA. In comparison to the US study (23), which reported use of LEV in some departments of the five facilities that were studied, none of the two hospitals in our study had LEV for cleaning and disinfecting tasks. It should be noted that the higher concentrations of OPA in the current study (compared to the US study) cannot be explained by the variability in frequency and duration of OPA use since the proportion of study participants that used OPA for one hour of less per day in this study (69%) was similar to the US study (71%) (23). Further comparisons with other studies that conducted environmental sampling for OPA could not be done since information about the frequency of OPA use was not included. Secondly, the higher levels of OPA observed in the current study could be explained by different work practices employed in these hospitals while conducting cleaning/disinfecting tasks, which probably resulted in HWs in this study being more exposed. It is well known that exposures associated with cleaning agents are a function of the manner in which tasks are performed as well as the chemical ingredients present in the cleaning products that are used (6). Finally, the use of manual versus automatic methods of OPA disinfection cannot explain the higher concentrations of OPA observed in the current study since manual methods were also used in the other studies reported. While only one department in this current study conducted automatic OPA disinfection, HWs in this department also performed manual OPA disinfection procedures.

Environmental sampling for formaldehyde has been conducted previously in US hospitals (a pathology and a histology laboratory in two different locations) using both active and passive methods (26). The median formaldehyde concentration reported ranged from 0.04 ppm using the active method to 0.05 ppm for the passive method. In contrast, formaldehyde levels (GM = 0.005 ppm) recorded in the current study were, on average, 10-fold lower (26)(26). The most likely reason for the observed differences is that the current study population did not include laboratory workers, who are well known for their higher usage of formaldehyde for specimen preparation compared to other categories of hospital workers. Furthermore, the formaldehyde levels in the current study are more comparable to average levels in US general buildings (41). Since only a small proportion of the variability in the formaldehyde levels obtained in the current study was explained by the departments, it is probable that the most likely source of exposure is the widespread use of formaldehyde (10%) solution used for specimen preparation in most departments, residue evaporation from formaldehyde contaminated surfaces and other general indoor sources.

The highest glutaraldehyde concentration measured during the pilot sampling conducted in the TAH was 0.028 ppm. This particular measurement was collected from a nurse working in an endoscopy unit with the highest duration (60 minutes) of glutaraldehyde usage for high-level disinfection of endoscopes. The average glutaraldehyde levels (GM = 0.006 ppm) in this study were similar to those reported by the Italian study of Marena and colleagues (mean = 0.005 ppm), slightly higher than the US study (range: not detected – 0.005 ppm), but lower than levels measured by the Canadian study (GM = 0.025 ppm) of five hospitals (23,38,39). Although glutaraldehyde levels in this study were below the ACGIH's TLV-Ceiling Limit, HWs reported work-related symptoms due to glutaraldehyde (Figure 4.1), underscoring the need to lower the regulatory exposure standards for this chemical.

In embarking on a sampling strategy for chlorhexidine, only few studies were identified, all reporting different methods for the determination of chlorhexidine and its metabolites (PCA and 1-chloro-4-nitrobenzene) in biological fluids (27). A number of challenges have been reported, including some being less sensitive, less specific, less accurate or some of them requiring a lengthy extraction process (27). This points to the lack of standardised, validated and sensitive methods for exposure assessment of chlorhexidine. An intensive literature search was unable to identify any study that has reported concentrations of chlorhexidine metabolites such as PCA in urine rendering comparisons with other studies impossible. While Wainwright and Cooke have described a method for detecting PCA in urine, it was not able to provide quantitative measures of exposure (28). Nevertheless, the findings of this study could be useful for future studies focussing on measuring PCA in urine.

To the best of our knowledge, this is the first study in Africa to conduct quantitative exposure assessment for aldehydes (OPA, glutaraldehyde and formaldehyde) in hospital settings. This study is also the first African study to have conducted biological monitoring for chlorhexidine exposures in HWs. The current study is also unique in that it was conducted in two different African hospital settings (SAH and TAH) using similar qualitative and quasi-quantitative exposure assessment methods for exposures to cleaning agents. Notably, the study has described the most common cleaning agents used for specific cleaning tasks in these settings and the typical durations of exposure to cleaning agents in different hospital departments in two geographical contexts.

There are some important limitations that need to be considered. The study initially sought to determine quantitative exposure to chlorhexidine and its metabolites (PCA and 1-chloro-4-

nitrobenzene) in urine. Due to logistical and methodological considerations, it was not possible to develop a multiplex assay for all these compounds except for PCA. Furthermore, although a robust assay for PCA was developed in the current study, it was not possible to compare with other studies because of lack of information in the literature. In this study, passive sampling was used for environmental exposure assessment of aldehydes. While environmental conditions such as temperature, relative humidity, ozone and air movements are well known factors that could affect the performance of passive samplers in measuring airborne aldehyde concentrations, these factors are less likely to have affected the study findings since most workers worked indoors, with insignificant air movements and temperatures that ranged between 22 to 30 degrees Celsius and relative humidity ranging between 40 – 68%. While ozone measurements have also been conducted in some studies, there were not done due to resource constraints. Additionally, due to logistical reasons, air measurements for some common cleaning agents such as bleach were not conducted in this study.

4.5. CONCLUSION

This study set out to characterise exposure of HWs to cleaning agents in two hospitals in sub-Saharan Africa. This study demonstrated a wide variety of chemicals used for cleaning and disinfection in these hospital settings, some of which are known to cause or aggravate respiratory and skin diseases such as asthma and contact dermatitis. Although the frequency and duration of use differed in these settings, the cleaning agents commonly used in this study were similar to those used in health care settings beyond sub-Saharan Africa. The study also confirmed that workplace controls for reducing exposure to cleaning agents were deficient. The study concluded that mean detectable exposures to OPA are higher and more isolated to certain departments and are dependent on the personal use of OPA, duration of use and job title in contrast to the more widespread low-level formaldehyde exposures present throughout the hospitals. There is a need for more standardized, sensitive and validated assays for the determination of chlorhexidine and its metabolites (PCA and 1-chloro-4-nitrobenzene) in biological fluids.

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CHAPTER 5

Prevalence of symptoms, allergic sensitisation and lung function abnormalities among health workers in the two large tertiary hospitals

ABSTRACT

Background: Health workers (HWs) are exposed to relatively higher concentrations of a wide range of chemicals used for cleaning and disinfection in health care facilities compared to domestic settings. This has been largely attributed to the ever-increasing demand for effective cleaning and disinfection in hospital settings in an effort to prevent healthcare associated infections, particularly due to the multi-drug resistant organisms. In recent years, there has been growing evidence linking cleaning agents to adverse health effects such as rhinitis, asthma and contact dermatitis. Most cleaning agents are irritants, however some have both irritant and sensitising properties. Some of the major sensitisers in hospital settings include aldehydes (glutaraldehyde and ortho-phthalaldehyde - OPA), quaternary ammonium compounds and natural rubber latex (NRL). The aim of this study was to determine the prevalence of work-related respiratory and skin symptoms, allergic sensitisation and lung function abnormalities among HWs in two large tertiary academic hospitals in sub-Saharan Africa.

Methods: A cross-sectional study of 699 HWs was conducted in two large tertiary hospitals. A total of 697 participants (n=344 - South Africa hospital, n=353 - Tanzanian hospital) underwent interviews using a modified version of the ECRHS questionnaire adapted for local conditions. Sera was collected from 682 participants and analysed for specific immunoglobulin E (sIgE) antibody reactivity to common aero-allergens (Phadiatop) and specific occupational allergens (NRL - *Hevea brasiliensis* (Hev b5, Hev b6.02), chlorhexidine and OPA). Methacholine challenge tests (MCT) were performed on all South African HWs (n=318), based on standard inclusion criteria. Spirometry, accompanied by a post-bronchodilator (post-BD) test was conducted on all Tanzanian HWs (n=329) and a small proportion (n=25) of South African HWs (SAHWs) where MCT was contraindicated. All HWs from both hospitals (n= 654) underwent Fractional Exhaled Nitric Oxide (FeNO) testing during the working day prior to spirometry.

Results: More than two thirds of the participants were women (78%), having a median age of 42 years (interquartile range - IQR: 32 – 51 years). Among the HWs investigated, 76% were registered, enrolled or assistant nurses, 12% cleaners and 5% administrative workers. Current smokers only formed 12% of the entire population surveyed, most being employed in the South African hospital (12% vs 1%). While 43% were atopic, a much lower prevalence of doctor-diagnosed asthma (7%) was found. The prevalence of specific sensitisation was highest to OPA (4%) compared to NRL (2%) and chlorhexidine (1%). The prevalence of work-related ocular-nasal symptoms in the past 12 months (16%) was higher than work-related skin (12%) and chest (7%) symptoms. Overall, the prevalence of skin symptoms (work-related and non-work-related) was significantly higher ($p < 0.001$) among HWs in the

South African hospital (SAH) compared to the Tanzanian hospital (TAH). However, Tanzanian HWs (TAHWs) had significantly lower lung volumes (adjusted) and a significantly ($p < 0.001$) higher degree of airflow obstruction compared to their counterparts. Among the SAHWs, 12% had non-specific bronchial hyperresponsiveness (NSBH), 10% positive on MCT and 2% positive on the post-BD test (an increase in FEV_1 of ≥12% and ≥200 milliliters post bronchodilator). Among the TAHWs, 6% demonstrated a positive post-BD test. Overall, 77% of all HWs had normal FeNO (<25 ppb) levels, 17% elevated (25–50 ppb) and 6% high (>50 ppb) levels suggestive of eosinophillic airway inflammation.

Conclusion: South African HWs experienced a higher prevalence of work-related skin symptoms compared to their Tanzanian counterparts, while THWs have comparatively lower lung volumes and higher degree of airflow obstruction. The findings from this study also suggest that the prevalence of NRL sensitisation is declining in South Africa most likely due to the NRL preventive measures implemented.

5.1. INTRODUCTION

There has been a growing demand for effective cleaning and disinfection in hospital settings in order to prevent healthcare associated infections, particularly due to the multi-drug resistant organisms (1). These efforts have resulted in extensive use of different types of cleaning chemicals in hospital settings. Consequently, health workers (HWs) in particular are exposed to higher concentrations of a wide range of chemicals. Several studies have demonstrated an association between exposure to cleaning agents and adverse health effects, commonly in the form rhinitis, asthma and contact dermatitis (2). HWs have therefore been identified as one of the occupational groups at high risk developing work-related asthma, due to their exposure to various products with irritative or allergenic properties such cleaning agents, natural rubber latex (NRL), methacrylates in dental and surgical cements, aerosolised medications (e.g. pentamidine), micro-organisms and mildew in certain contexts (3,4).

Health workers are exposed to various cleaning agents including high-level disinfectants used for heat-sensitive medical equipment such as endoscopes. Of particular importance are the two aldehydes, glutaraldehyde and ortho-phthalaldehyde (OPA). Glutaraldehyde has been used for over 40 years in health care settings and has been linked to various health effects such as occupational asthma and allergic contact dermatitis (5,6). Due to these health effects, OPA was introduced as a safer alternative to glutaraldehdye in some health care settings. However, OPA has also been recently reported to cause occupational asthma and anaphylaxis in various case reports, including patients undergoing instrument procedures (7). Despite this, only a few studies have been conducted to assess the immunological mechanisms in individuals suspected to have OPA allergy and none of those studies have been conducted in Africa (7). In addition, most of these studies have been case reports involving a small number of participants (7). In a Japanese study among 70 HWs responsible for endoscope disinfection, 24% had work-related skin, respiratory or eye symptoms due to OPA (8). Work-related symptoms due to OPA were also reported in another Japanese study among 80 female HWs from endoscopy units, with respiratory symptoms being the majority (16%), followed by skin (10%) and eye (9%) symptoms (9). However, both of these two studies did not perform specific immunological test for OPA (8,9). Recently, a team of National Institute for Occupational Safety and Health (NIOSH) conducted skin prick tests (SPT) and specific immunoglobulin E (sIgE) and IgG assessment for OPA among 129 US health workers (10). In this US study, 5 (4%) HWs had positive skin responses to SPTs with OPA solution but none had detectable sIgE and IgG antibodies in any of the blood samples tested (10).

Exposure to chemicals contained in hand hygiene products is also quite common in hospital settings since HWs are required to wash and disinfect their hands several times per day in order to comply with infection control standards. Chorhexidine is one of the most commonly encountered chemical used in hand hygiene products. It is also used for disinfection of wounds and patients' skin before various medical procedures. Chlorhexidine is a known sensitiser and irritant to both the skin and airways (11). There have been a few published reports of asthma and dermatitis due to chlorhexidine, mostly among patients and a few reported in HWs (12–16). Nagendran *et al*. identified 4 cases of occupational IgE-mediated allergy to chlorhexidine among 53 HWs in the United Kingdom (UK) hospital (14). Urticaria was reported in all 4 cases identified, with one also having rhinitis and another with contact dermatitis (14). Furthermore, in this study 3 cases had positive reactions to SPT and 2 had positive sIgE to chlorhexidine (14). Wittczak *et al*. have also described 3 cases of occupational allergy among HWs confirmed by placebo-controlled specific bronchial challenge testing (15). One case was diagnosed with occupational asthma, the second with both occupational asthma and rhinitis, while the third case had an anaphylactic reaction to chlorhexidine (15). Serum sIgE to chlorhexidine was positive in all the 3 identified cases but only 2 had positive SPT (15). To the knowledge of the investigators, no studies have been conducted on the immunological assessment for chlorhexidine in Africa.

Although the incidence of sensitization to NRL allergens has decreased to 1% in the countries that have promoted latex avoidance, HWs in the least developed countries continue to use significant amounts of powdered NRL gloves (17). The prevalence of NRL allergy among HWs has been reported to range between 3% and 31% in different studies globally (17–19). In South Africa, the prevalence of NRL sensitisation has ranged between 5% and 21% among HWs (20–25). The prevalence of NRL sensitization and allergy is unknown in Tanzania. The most common NRL allergens associated with latex allergy in health workers are Hev b 5, Hev b 6.01 and Hev b 6.02 (26,27). The changeover to latex free gloves in South Africa has been sporadic and inconsistent especially in resource constrained settings. These NRL allergens (Hev b 5 and Hev b 6.02) were found to be elevated in gloves being used in public sector academic dental teaching hospitals in South Africa (28).

Studies that have conducted exhaled nitric oxide (FeNO) tests in HWs exposed to cleaning agents are limited. An Italian study (29) did not find any difference in FeNO between hospital cleaners and a control group of students as well as other hospital employees not exposed to cleaning agents. Similarly, a Spanish study of professional cleaners (including hospital cleaners) did not observe any difference in FeNO between asthma cases and controls (30). However, higher FeNO levels were associated with work-related use of multi-use products, glass cleaners and polishes (30). Furthermore, a French study among domestic cleaners reported higher FeNO levels among non-asthmatics who used sprays, especially glass cleaning sprays and acids (31).

The aim of this study was to determine the prevalence of work-related respiratory and skin symptoms, allergic sensitisation and lung function abnormalities among HWs in two large tertiary academic hospitals in sub-Saharan Africa.

5.2. METHODS

5.2.1. Study design, Population and Sampling

A cross-sectional study of **699** HWs was conducted in two large tertiary academic hospitals (**346** from a South Africa hospital – SAH and **353** from Tanzanian hospital - TAH). Following meetings with several key stakeholders and walk-through inspections by the investigators of both hospitals, specific departments were identified as potentially high-risk exposure settings for cleaning agents. Health workers in these high-risk departments used significant amounts of cleaning agents at a frequency much higher than other departments. The departments identified in the SAH included out-patient clinics, intensive care units (ICUs), operating theaters, emergency units, ENT ward, vascular radiology and the haemodialysis unit. The out-patient clinics, ICUs, operating theaters, emergency unit, Central Sterile Services Department (CSSD) and haemodialysis unit were identified in the TAH.

All permanently employed HWs in the high-risk departments constituted the sampling frame of the study. Doctors were excluded from the sampling frame as they were more likely to work in multiple different exposure settings across the hospital. A list of all permanently employed HWs in the high-risk departments was obtained from their respective managers. Study participants were selected from these departments through stratified random sampling according to job title, choosing up to five HWs from each high-risk department. For departments having more than five HWs with the same job title, a random sample of five workers was selected. For departments having less than five workers, all workers were selected to participate in the study. Ethics approval was obtained from the Human Research Ethics Committee (HREC) of the University of Cape Town (HREC Ref: 212/2013), Muhimbili University of Health and Allied Sciences (MUHAS) Institutional Review Board and University of Michigan Medical School Institutional Review Board (HUM00083115).

5.2.2. Questionnaire

A total of **697** participants completed the questionnaire interviews (**344** from SAH and **353** from TAH). Each participant answered a modified questionnaire for the investigation of asthma as contained in the Protocol for the European Community Respiratory Health Survey (32). The study questionnaire also included validated questions from the NIOSH specific questionnaire for cleaning agents in the health care setting (33). The questionnaire was administered by trained interviewers in English language for South African health workers (SAHWs) and in Swahili language for Tanzanian health workers (TAHWs). The translated Swahili questionnaire was back-translated to ensure validity and repeatability.

5.2.3. Immunological assessment

Blood samples were collected from **682** participants (**339** SAHWs and **343** TAHWs). Specific IgE antibody reactivity to common aero-allergens (Phadiatop) and specific occupational allergens was evaluated. The quantification of specific IgE antibodies to specific occupational allergens: NRL (*Hevea brasiliensis* - Hev b5, Hev b6.02), chlorhexidine and OPA was performed using the UniCAP system (Phadia, Uppsala, Sweden). Immunological assessment for chlorhexidine was only done on sera of SAHWs since chlorhexidine containing chemicals were not used in the TAH.

Commercial ImmunoCAPs containing Phadiatop (Phad), Chlorhexidine (C8), rHev b5 (K218) and rHev b6.02 (K220) allergens were obtained from Thermo Scientific. Serum samples were tested at the National Institute for Occupational Health (NIOH) Immunology laboratory using the UNICAP 250 machine supplied by Thermo Scientific according to the manufacturer manual. This instrument uses the fluorescent enzyme immunoassay (FEIA) technique in an automated process. Briefly, serum is added to allergen of interest that is covalently coupled to ImmunoCAP. If specific IgE is present in the serum being tested, it will bind to the antigen and form an antigen–antibody complex. After washing away non-specific IgE, a fluorescent labelled anti human immunoglobulin is added that binds to the unwashed antigen–antibody complex. The fluorescent colour is converted into specific IgE concentrations by the machine software.

Since the OPA test was not readily available commercially, it required further development. Ortho-phthalaldehyde (OPA) was coupled to albumin using a modification of the ELISA method by Suzukawa *et al*., 2007, Anderson *et al*., 2010 and Johnson *et al*., 2011 (34–36). A 4% (40mg in 1ml) solution of bovine serum albumin (BSA) (GE healthcare life sciences, cat no: SH30574.02) was prepared in phosphate buffered saline (PBS) (Roche, cat no: 11 418 165 001) and a 2.2 % (22mg in 1ml) solution of OPA (Sigma, cat no: P1378-5G) was prepared in sterile water. Equal amounts (500µl) of BSA and OPA solutions were mixed resulting in a final concentration of 2 % BSA and 1.1 % OPA.

This mixture was labelled with Biotin and separated on a Sephadex G-25 column using the Biotin labelling kit from Roche according to the manufacturer's instructions (Roche, cat no: 11 418 165 001). Briefly 6.7µl of Biotin-7-NHS was added to the BSA/OPA mix and incubated for 2 hours at 15-25^{0}C while stirring. The Sephadex G-25 column was prepared by adding 5 ml of blocking solution to the column and allowed to flow through. Thereafter, the column was rinsed 6 times with 5ml of PBS. The biotin labelled protein mixture was added to the column. This was then eluted with 3.5ml of PBS and 40 drops of labelled protein was collected and used as the allergen.

The ImmunoCAPs were then washed and placed in a 2ml Eppendorf with a pipette tip. These were then centrifuged to get rid of the glycerol for 2 min 1450g. ImmunoCAPs were washed and centrifuged 4 times with 50 µl ImmunoCAP Washing solution. Washed ImmunoCAPs were placed in a microtiter plate and 50 µl of biotinylated allergen was added into each ImmunoCAP. After 30 minutes the ImmunoCAPs were put into a carrier and loaded into the Phadia250 machine. Specific IgE antibodies to prepared OPA allergens were then measured using the UNICAP 250 machine according to manufacturer's procedure.

Individuals with atopy were defined as those having a positive Phadiatop test. Individuals with sensitization to specific occupational allergens were identified based on sIgE ≥ 0.35 KU/L.

5.2.4. Spirometry (pre and post-bronchodilator)

There were **328** participants from the TAH and **25** participants from the SAH who performed spirometry (pre- and post-bronchodilator). The latter group did not proceed to methacholine challenge testing (see below) due to contra-indications (e.g. FEV_1 below 1.5 litres or 70% predicted, pregnant and breastfeeding women). Spirometry was conducted according to guidelines of the American Thoracic Society/European Respiratory Society (ATS/ERS) (37) using EasyOne World spirometer (ndd Medical Technologies, Zurich, Switzerland) at the TAH and Jaeger Aerosol Provocation System (APS) Pro apparatus at the SAH according to the manufacturer's instructions. Special instructions were given to health workers to abstain from smoking tobacco (at least 2 hours before) taking any anti-asthmatic inhalers (12 hours before) or oral asthma medications (48 hours before) prior to the test. The Global Lung Function Initiative (GLI) 2012 reference values using "other" ethnic group were used for grading degree of impairment of spirometry (38). A change in FEV_1 of ≥200 milliliters and ≥12% 10 minutes after the administration of bronchodilator (400 µg of salbutamol) was considered to be significant bronchial reversibility. To achieve additional quality control for the Tanzanian group that did not perform methacholine challenge tests (due to logistical considerations), each spirometric test was evaluated for the quality according to the ATS standards (39) as outlined in Table 5.1, which compares grading between the Easyone spirometer output and the ATS grading. All spirometric tests with ATS quality grade F were not included in the analysis. Data from **182** participants were available after excluding those with ATS grade D, E and F on pre-bronchodilator (pre-BD) tests.

Table 5.1: Spirometry quality grades of health workers in the Tanzanian hospital

	Pre-BD Easyone grade n (%)	**Pre-BD ATS grade** n (%)	**Post-BD Easyone grade** n (%)	**Post-BD ATS grade** n (%)
A	86 (26)	129 (39)	132 (41)	175 (54)
B	43 (13)	69 (21)	43 (13)	40 (12)
C	102 (31)	34 (10)	57 (18)	18 (6)
D	97 (29)	9 (3)	75 (23)	13 (4)
E		87 (26)		61 (19)
F	3 (1)	3 (1)	18 (6)	18 (6)
Total	331	331	325	325

Note: Those with ≥2 acceptable tests with repeatability of > 0.250 L were assigned ATS grade E

5.2.5. Methacholine challenge tests

Methacholine challenge testing (MCT) was only performed in the South African study site due to logistical considerations. The tests were conducted in a pulmonary function laboratory that was well equipped with appropriate resuscitation facilities. Among **318** participants who underwent spirometry, **239** performed interpretable PD_{20} methacholine results while **52** participants had ≥10% decrease in FEV_1 after administration of saline diluent and were therefore not considered for MCT. MCT was discontinued in **two** participants who requested the test to be stopped. As explained above, **25** participants underwent post-bronchodilator spirometry, since MCT was contraindicated. MCT was conducted under the supervision of an experienced technologist according to an abbreviated protocol used in epidemiological surveys. The Medic Aid Pro Nebulizer dosimeter method involved a protocol of increasing numbers of breaths to achieve pre-defined cumulative doses of methacholine (40). The doses were delivered by the Jaeger APS MedicAid Side Stream APS-Nebulizer according to the manufacturer's instructions, commencing with the lowest dose of 0.026 mg. The dose was increased to a maximum of 2.048 mg methacholine if a positive endpoint (fall in FEV_1 of 20% or more) was not obtained. The results of the MCT were interpreted as follows: borderline defined as 0.4mg $<PD_{20}M<$1.0 mg; mild = 0.08 mg $< PD_{20}M <$0.4mg; moderate/severe = $PD_{20}M<$ 0.08mg. Borderline values for $PD_{20}M$ were considered negative in the definition of non-specific bronchial hyper responsiveness (NSBH). These cut-offs for the APS system are based on the results from a validation study performed on 40 hyper-responsive bakery workers that confirmed a satisfactory correlation between the APS cumulative $PD_{20}M$ method and the standard VMAX (Sensormedics) method (34). A urine pregnancy test was offered to women prior to the administration of methacholine, while pregnant women and nursing mothers were automatically excluded from testing.

5.2.6. Fractional exhaled nitric oxide (FeNO)

A total of **654** participants performed FeNO tests (**334** from SAH and **320** from TAH). A hand-held portable exhaled nitric oxide sampling device (NIOX MINO® Airway Inflammation Monitor (NIOX MINO); Aerocrine AB, Solna, Sweden) was used. Under guidance of clinical personnel, all HWs inhaled NO-free air close to total lung capacity and exhale for 10 seconds at a flow rate of 50 ml/sec according to the manufacturer’s instructions. Two technically adequate measurements were performed in line with the current American Thoracic Society /European Respiratory Society recommendations (41). A third maneuver was performed if the difference between the first two measurements was more than 10 ppb. The FeNO test was done during the work shift before spirometry / MCT. Special instructions were provided to workers to ensure that tested individuals did not smoke tobacco, eat or drink (at least 1 hour before) prior to the test. Ambient NO and temperature were also recorded. FeNO results were interpreted as follows: low < 25ppb; elevated for values 25 - 50ppb; and high for values > 50ppb (42).

5.2.7. Statistical analysis

All data analysis was performed using statistical package STATA version 14. Frequencies of categorical variables were compared between the two hospitals using Chi-squared test or Fisher’s exact test where appropriate. Numerical variables were summarised using median and interquartile range, since not all variables followed a normal distribution. Numerical variables were compared between the two hospitals using Wilcoxon sum rank test.

5.3. RESULTS

5.3.1. Study population

Demographic characteristics of the study population are summarised in Table 5.2. The majority of study participants were women (78%), having a median age of 42 years (interquartile range - IQR: 32 – 51 years) and had worked in the healthcare industry for 14 years (median: 14 years; IQR: 6 – 28 years). A significant number of study participants (76%) were nursing professionals (registered nurses, enrolled nurses and nurse assistants or health attendants). Cleaners (12%) and other health workers including administrative workers (5%) were also included in the study. South African HWs were significantly older, with higher BMI (although comparable to their respective general populations), and a higher prevalence of current smoking, atopy and past history of tuberculosis compared to their counterparts. However, a history of repeated childhood chest infections was significantly higher among Tanzanian HWs (p-value = 0.001).

Table 5.2: Demographic characteristics of health workers in the two tertiary hospitals

Demographic characteristics	Overall	SAH n (%)	TAH n (%)	p-value (Chi-squared test)
Participants (n)	**697**	**344**	**353**	
Age (years) [median (IQR)]	42 (32 – 51)	46 (33 – 51)	39 (31 – 51)	0.009*
Gender (%F:M)	77:23	84:16	71:29	<0.001
BMI [median (IQR)]	29 (26 – 34)	31 (27 – 37)	28 (25 – 32)	<0.001*
Smoking status: n (%)				<0.001
Current smokers	42 (6)	40 (12)	2 (1)	
Ex-smokers	48 (7)	48 (14)	0 (0)	
Never smokers	607 (87)	256 (74)	351 (99)	
Job title: n (%)				<0.001
Registered nurse	283 (41)	132 (38)	151 (43)	
Nurse assistant / Health attendant	168 (24)	59 (17)	109 (31)	
Enrolled nurse	75 (11)	48 (14)	27 (8)	
Cleaner	85 (12)	45 (13)	40 (11)	
Clerk	38 (5)	13 (4)	25 (7)	
Technician	34 (5)	33 (10)	1 (0)	
Porter	14 (2)	14 (4)	0 (0)	
Total years in healthcare industry [median (IQR)]	14 (6 – 28)	20 (8 – 28)	11 (4 – 27)	<0.001*
Total years in the current job [median (IQR)]	4 (2 – 9)	4 (1 – 11)	4 (2 – 8)	0.862*
Past history of lung disease (self-reported)				
Previous treatment for chronic bronchitis	44 (6)	42 (12)	2 (1)	<0.001
Repeated childhood chest infections	76 (11)	24 (7)	52 (15)	0.001
Previous treatment for tuberculosis	32 (5)	22 (6)	10 (3)	0.025
Family history of allergy	353 (51)	219 (64)	134 (38)	<0.001
Cleaning activities at home in the last 12 months	660 (95)	342 (99)	318 (90)	<0.001
Less than 1 day per week	96 (14)	17 (5)	79 (22)	<0.001
1 or more days per week	601 (86)	327 (95)	274 (78)	

SAH: South African hospital; TAH: Tanzanian hospital; F: female; M: male; IQR: interquartile range; *: Wilcoxon sum rank test

5.3.2. Immunological characteristics

The prevalence of atopy (positive Phadiatop test) was higher (47%) in South African HWs (p = 0.047) (Table 5.3). The prevalence of OPA sensitisation was relatively low, although relatively higher (4%) than for natural rubber latex (Hev b5 or Hev b6.02) (2%), but with no significant difference observed between the two hospitals. The prevalence of chlorhexidine sensitisation was only 1% among SAHWs. As explained earlier, immunological assessment for chlorhexidine was not conducted for THWs.

Table 5.3: Allergic sensitisation profiles of health workers in the two tertiary hospitals

Allergic sensitisation profiles	**Overall**	**SAH n (%)**	**TAH n (%)**	**p-value** (Chi-squared test)
Participants (n)	**682**	**339**	**343**	
Atopy (Positive Phadiatop test)	296 (43)	160 (47)	136 (40)	0.047
OPA	26 (4)	12 (4)	14 (4)	0.712
Chlorhexidine	NA	3 (1)	ND	NA
Latex (Hev b5 or Hev b6.02)	11 (2)	7 (2)	4 (1)	0.352
Latex Hev b5	3 (0)	3 (1)	0 (0)	0.122#
Latex Hev b6.02	8 (1)	4 (1)	4 (1)	1.000#
Sensitisation to at least one occupational allergen (OPA, Chlorhexidine or Latex)*	34 (5)	19 (6)	15 (4)	0.460

Peroxidase: 19 (6); SAH: South African hospital; TAH: Tanzanian hospital; OPA: ortho-phthalaldehyde; ***:** Sensitisation to at least one occupational allergen (OPA, Chlorhexidine or Latex) and peroxidase negative (in relation to latex) ;#: Fisher's exact test; NA: Not applicable; ND: Not done

5.3.3. Symptoms

Although the prevalence of doctor-diagnosed asthma was 7%, with no significant difference between the two hospitals (Table 5.4), the majority (60%) of these individuals reported adult-onset asthma. A higher prevalence of SAHWs (17%) had an asthma symptom score ≥2 compared to their Tanzanian counterparts (9%). Overall, the prevalence of work-related ocular-nasal symptoms in the past 12 months (16%) was higher than work-related skin (12%) and asthma (7%) symptoms (Table 5.6). The prevalence of skin symptoms (work-related and non-work-related) was significantly higher among HWs in the SAH compared to the TAH ($p < 0.001$) (Table 5.5 and 5.6). Skin symptoms commonly affected the hands or forearms (12%), compared to the whole body (5%). There were 16 (2%) workers from both hospitals who reported job changes due to work-related chest symptoms. The major agents attributed for these work-related chest symptoms by respondents included the general dust, NRL and OPA / glutaraldehyde.

Table 5.4: Asthma history and respiratory symptoms reported by health workers in the two tertiary hospitals

Symptoms	Overall	SAH n (%)	TAH n (%)	p-value (Chi-squared test)
Participants (n)	697	344	353	
Asthma history				
Ever attacks of breathlessness at rest with wheezing	33 (5)	13 (4)	20 (6)	0.241
Ever asthma	52 (8)	28 (8)	24 (7)	0.501
Ever asthma attack	55 (8)	26 (8)	29 (8)	0.748
Doctor-diagnosed asthma	48 (7)	29 (8)	19 (5)	0.112
≤16 years	19 (3)	9 (2)	10 (3)	0.135
>16 years	29 (4)	20 (6)	9 (2)	
Current use of asthma medication	39 (6)	21 (6)	18 (5)	0.564
Asthma attack in the past 12 months	31 (5)	16 (5)	15 (4)	0.797
Current use of asthma medication OR Asthma attack in the past 12 months	44 (6)	24 (7)	20 (6)	0.477
Asthma-like symptoms	219 (31)	154 (45)	65 (18)	<0.001
Short of breath while wheezing in the last 12 months	67 (10)	38 (11)	29 (8)	0.214
Woken up with chest tightness in the last 12 months	85 (12)	51 (15)	34 (10)	0.039
Attack of shortness of breath at rest during daytime in the last 12 months	51 (7)	18 (5)	33 (9)	0.035
Attack of shortness of breath following running or exercise in the last 12 months	154 (22)	128 (37)	26 (7)	<0.001
Woken up by an attack of shortness of breath in the last 12 months	48 (7)	26 (8)	22 (6)	0.503
More symptomatic (≥ 2 asthma-like symptoms)	91 (13)	58 (17)	33 (9)	0.003
Less symptomatic (0 – 1 asthma-like symptom)	606 (87)	286 (83)	320 (91)	
Asthma symptom score				<0.001
0	478 (69)	190 (55)	288 (82)	
1	128 (18)	96 (28)	32 (9)	
2	42 (6)	31 (9)	11 (3)	
3	17 (2)	11 (3)	6 (2)	
4	18 (3)	10 (3)	8 (2)	
5	14 (2)	6 (2)	8 (2)	
Upper airway symptoms				
Presence of ocular–nasal symptoms ever	306 (44)	167 (49)	139 (39)	0.015

SAH: South African hospital; TAH: Tanzanian hospital

Table 5.5: Skin symptoms reported by health workers in the two tertiary hospitals

Symptoms	**Overall**	**SAH n (%)**	**TAH n (%)**	**p-value** (Chi-squared test)
Participants (n)	697	344	353	
Presence of skin symptoms ever	215 (31)	148 (43)	67 (19)	<0.001
Two or more episodes of skin symptoms in the last 12 months	125 (18)	82 (24)	43 (12)	<0.001
Symptoms affecting hands or forearms#	86 (12)	50 (15)	36 (10)	0.082
Itchy/scratchy skin	72 (10)	40 (12)	32 (9)	0.266
Redness of the skin	45 (7)	34 (10)	11 (3)	<0.001
Burning skin	24 (3)	22 (6)	2 (1)	<0.001
Hives	15 (2)	9 (3)	6 (2)	0.404
Dry/scaly skin	7 (1)	0 (0)	7 (2)	0.015*
Blisters/weeping skin	10 (1)	6 (2)	4 (1)	0.541*
Rash within an hour of contact with a rubber latex product	8 (1)	7 (2)	1 (0)	0.036*
Symptoms affecting the whole body#	36 (5)	22 (6)	14 (4)	0.147
Itchy/scratchy skin	34 (5)	20 (6)	14 (4)	0.257
Redness of the skin	21 (3)	15 (4)	6 (2)	0.040
Burning skin	11 (2)	11 (3)	0 (0)	0.001
Hives	6 (1)	3 (1)	3 (1)	1.000*
Dry/scaly skin	9 (1)	9 (3)	0 (0)	0.002*
Blisters/weeping skin	2 (0)	1 (0)	1 (0)	1.000*
Rash within an hour of contact with a rubber latex product	1 (0)	1 (0)	0 (0)	0.494*

SAH: South African hospital; TAH: Tanzanian hospital; *: Fisher's exact test;
#: presence of itchy/scratchy skin, hives, dry/scaly skin, redness of the skin, blisters/weeping skin or burning skin

Table 5.6: Work-related symptoms reported by health workers in the two tertiary hospitals

Symptoms	Overall	SAH n (%)	TAH n (%)	p-value (Chi-squared test)
Participants (n)	697	344	353	
Work-related asthma symptoms				
Episode of high exposure at work causing tight chest, shortness of breath, wheeze or cough	3 (0)	2 (1)	1 (0)	0.043
Work-related asthma symptoms (ever)	83 (12)	38 (11)	45 (13)	0.488
Work-related asthma symptoms in the past 12 months [a]	65 (9)	28 (8)	37 (11)	0.288
Work-related asthma symptoms in the past 12 months [b]	48 (7)	20 (6)	28 (8)	0.270
Doctor-diagnosed work-related asthma (ever)	15 (2)	8 (2)	7 (2)	0.755
Job change due to work-related chest symptoms	16 (2)	10 (3)	6 (2)	0.287
Work-related upper airway symptoms				
Work-related ocular–nasal symptoms (ever)	163 (23)	80 (23)	83 (24)	0.936
Work-related ocular–nasal symptoms in the past 12 months [a]	146 (21)	70 (20)	76 (22)	0.702
Work-related ocular–nasal symptoms in the past 12 months [b]	109 (16)	48 (14)	61 (17)	0.227
Doctor-diagnosed work-related ocular–nasal symptoms (ever)	19 (3)	9 (3)	10 (3)	0.861
Work-related skin symptoms				
Work-related skin symptoms (ever)	130 (19)	95 (28)	35 (10)	<0.001
Work-related skin symptoms in the past 12 months [a]	103 (15)	76 (22)	27 (8)	<0.001
Work-related skin symptoms in the past 12 months [b]	80 (12)	61 (18)	19 (5)	<0.001
Doctor-diagnosed work-related skin condition(ever)	20 (3)	16 (5)	4 (1)	0.005

SAH: South African hospital; TAH: Tanzanian hospital;
[a]: Symptoms (asthma / ocular-nasal / skin) experienced at work in the last 12 months;
[b]: Symptoms (asthma / ocular-nasal / skin) experienced at work in the last 12 months that gets better when away from work OR worsen on return to work

5.3.4. Pulmonary function tests (spirometry, MCT and FeNO)

The results of the pulmonary function tests are summarised in Table 5.7. Overall, TAHWs had significantly lower lung volumes and a higher prevalence of airflow obstruction than their counterparts ($p < 0.001$). While 29% of workers had an FEV_1 of less than lower limit of normal (LLN), 11% had evidence of airflow obstruction (pre-bronchodilator FEV_1/FVC ratio less than LLN). In the South African group, 12% of workers had evidence of NSBH (10% positive on methacholine challenge test - PD_{20} methacholine < 0.4 mg, and 2% with significant bronchial reversibility). In the Tanzanian group, 6% of HWs had evidence of NSBH on the basis of significant bronchial reversibility. Overall, combining results from both hospitals, 9% of the study population had evidence of NSBH.

The median FeNO levels (interquartile range: 11 – 24) were slightly higher among SAHWs compared to the Tanzanian counterparts. Overall across all hospitals, 77% had low FeNO (<25 ppb), 17% elevated (25–50 ppb) levels and 6% high (>50 ppb) levels. The proportion of HWs with high FeNO, was slightly higher in the South African group.

Table 5.7: Pulmonary function indices of health workers in the two tertiary hospitals

Pulmonary function indices #‡	Overall	SAH n (%)	TAH n (%)	p-value (Chi-squared test)
Participants (n)	**646**	**318**	**328**	
FVC L [median (IQR)]	3.02 (2.47 – 3.53)	3.23 (2.80 – 3.68)	2.68 (2.21 – 3.35)	<0.001*
FEV_1 L [median (IQR)]	2.42 (1.96 – 2.88)	2.66 (2.30 – 3.07)	2.16 (1.78 – 2.65)	<0.001*
FEV_1 /FVC, % [median (IQR)]	82 (77 – 86)	83 (80 – 87)	81 (76 – 85)	<0.001*
FVC % pred. [median (IQR)]	91 (79 – 103)	99 (90 – 108)	82 (73 – 94)	<0.001*
FEV_1 % pred. [median (IQR)]	89 (76 – 101)	99 (89 – 108)	79 (70 – 90)	<0.001*
FVC < 80% pred.	168 (26)	24 (8)	144 (44)	<0.001
FVC < LLN (n,%)	172 (27)	24 (8)	148 (45)	<0.001
FEV_1< 80% pred. (n,%)	205 (32)	33 (10)	172 (52)	<0.001
FEV_1< LLN (n,%)	185 (29)	26 (8)	159 (49)	<0.001
FEV_1 /FVC < LLN (n,%)	73 (11)	20 (6)	53 (16)	<0.001
FEV_1 /FVC < 70% (n,%)	50 (8)	14 (4)	36 (11)	0.002
Bronchial hyperresponsiveness				
≥12% and ≥200 ml FEV_1 increase post-bronchodilator	**n = 207** 26 (13)	**n = 25** 7 (28)	**n = 182** 19 (10)	NA
≥10% FEV_1 decrease post-saline diluent (n = 291)		52 (18)	ND	NA
Methacholine challenge test: PD_{20} methacholine < 0.4 mg (n = 239)		31 (13)	ND	NA
NSBH## (n = 264)		38 (14)	ND	NA
Fractional exhaled nitric oxide (FeNO)	**n = 654**	**n = 334**	**n = 320**	
FeNO (ppb) [median (IQR)]	17 (11 – 24)	17 (12 – 25)	15 (10 – 22)	0.003*
Low <25 ppb	504 (77)	251 (75)	253 (79)	0.487
Elevated 25 – 50 ppb	111 (17)	61 (18)	50 (16)	
High >50 ppb	39 (6)	22 (7)	17 (5)	

SAH: South African hospital; TAH: Tanzanian hospital; FEV_1: forced expiratory volume in 1 second; FVC: forced vital capacity; L: litres; LLN: Lower limit of normal;IQR: interquartile range; % pred: % predicted; PD_{20} methacholine: provocative dose of methacholine causing a ≥ 20% fall in FEV_1; NSBH: nonspecific bronchial hyperresponsiveness; ND: Not done; NA: Not applicable; #: pre-bronchodilator values, unless stated otherwise; ‡:Global lung function initiative (GLI) reference values used; ##: NSBH defined as any of the following two criteria: PD_{20}methacholine <0.4 mg OR≥12% and ≥ 200 ml increase in FEV_1 after administration of a bronchodilator; *: Wilcoxon sum rank test;

5.4. DISCUSSION

The findings of this study has demonstrated that HWs in two tertiary academic hospitals in sub-Saharan Africa experience an appreciable proportion of work-related airway and skin symptoms as their counterparts in other regions of the world. While South African HWs reported a higher prevalence of work-related skin symptoms, Tanzanian HWs had comparatively higher proportion of individuals with decreased lung volumes and airflow obstruction. The study has also confirmed that the prevalence of NRL sensitisation has declined in South Africa over the past decade.

As has been reported in most studies of work-related rhinitis and asthma (43), the prevalence of work-related ocular-nasal symptoms was twice as common as asthma symptoms in this study. Furthermore, in this current study, lifetime prevalence of work-related ocular-nasal (23%) and asthma symptoms (12%) was higher than that reported in South African dental HWs (14% and 4% respectively) (25). Moreover, in this current study, the prevalence of work-related asthma symptoms (WRAS) in the past 12 months (7%) was higher than a US study of HWs (3.3%) and on the upper end of the range compared to the Saudi Arabian study of HWs (5.7%), both using a similar definition of WRAS (44,45). Although the authors did not comment on the available workplace controls in the two studies (44,45), the inadequate workplace controls observed in the current study could partly explain the relatively higher prevalence of WRAS. In addition, 16 (2%) workers with WRAS in the current study had to change their jobs due to these symptoms, underscoring the negative consequences associated with work-related asthma (46).

Unlike upper and lower airway symptoms that were similar across both study groups, a higher prevalence of skin symptoms (work-related and non-work-related) was reported among SAHWs in this study, although there was no correlation between the presence of respiratory and skin symptoms. This could partially be explained by the significantly ($p<0.001$) higher frequency of hand washing at work among South African HWs (58 times per day), compared to Tanzanian HWs (20 times per day). Another possible explanation could be the different hand hygiene products used, with SAHWs using mostly chlorhexidine containing products and alcohols compared to the TAHWs who used mainly a diluted all-purpose cleaner and alcohols. Chlorhexidine is a well known skin irritant and allergen capable of causing both IgE-mediated (e.g. urticaria) and delayed type (e.g. contact dermatitis) hypersensitivity skin reactions (11,47). The predominance of skin symptoms affecting the hand/forearms rather than the whole body, suggests a clinical picture of a contact dermatitis, although contact urticaria cannot be ruled out completely. However, since skin patch testing was not performed in this study it was not possible to characterise this further as to whether they were allergic or irritant in nature. The prevalence of work-related skin symptoms (lifetime = 19% and in the past 12 months = 12%) in the current study is consistent with results from previous studies (11% - 28%) among workers exposed to cleaning agents in other parts of the world (48–51).

In this study, the prevalence of atopy (positive Phadiatop test) was higher (47%) in the SAHWs compared to the TAHWs (40%) and on upper end of other workplace-based South African studies (36 – 46%) (25,52–54). However, the overall atopy prevalence (43%) in this study was similar to that observed (45%) in a US study of HWs (10). In the latter study, among the 129 participants evaluated for sensitisation to OPA, 5 (4%) had positive skin responses to SPTs with OPA solution (10). While the reported prevalence of OPA sensitisation in the US study is similar to that observed in the current study, interestingly, sIgE and IgG antibodies were not detected in any of the blood samples tested. Since the current study only used sIgE to OPA in the immunological assessment, it is probable that a higher prevalence of OPA sensitisation could have been obtained had SPT been used, since sIgE determination is a measure of circulating antibodies and fails to detect locally bound IgE. Interestingly, in the current study, prevalence of work-related symptoms due to OPA (4%) was similar to the prevalence of OPA sensitisation (4%), with HWs experiencing more ocular-nasal symptoms (3%) compared to chest (2%) and skin (1%) symptoms. As expected, prevalence of work-related symptoms due to OPA was much higher (9% - 24%) in the two Japanese studies that only investigated HWs exposed to OPA in the endoscopy units (8,9).

Despite 20% of SAHWs reporting work-related symptoms due to chlorhexidine in this study, only three (1%) HWs had evidence of chlorhexidine sensitisation. Since Tanzanian HWs did not use chlorhexidine containing products, immunological assessment for chlorhexidine was not evaluated. The low prevalence of chlorhexidine sensitisation in this study is similar to the findings by Garvey *et al* that did not identify any HW with sensitisation to chlorhexidine using a series of immunological skin tests (skin prick, intradermal and patch tests) (12). Four cases of occupational IgE-mediated allergy to chlorhexidine were diagnosed among 53 HWs in the UK hospital (14). Among the 4 cases of occupational chlorhexidine allergy identified, 3 HWs had positive SPT responses while two had a positive (≥ 0.35 KU/L) sIgE test (14). Wittczak *et al*. have also described 3 cases of among HWs in Poland with all 3 identified cases having positive sIgE tests and only 2 with positive SPT (15). Interestingly, only one was atopic (positive SPT to common aeroallergens) while another case had concurrent NRL allergy confirmed by sIgE and a positive specific bronchial challenge test. In contrast, several cases of chlorhexidine allergy have been frequently reported among patients (16) and coexistence of chlorhexidine and NRL allergy has also been observed in other studies (14,55).

In this current study, the prevalence of NRL sensitisation was 2% compared to a previous study (22) conducted more than a decade ago in the same SAH, which reported a 9% prevalence of NRL sensitisation. The decline in prevalence of NRL sensitisation is most likely related to the latex avoidance measures implemented in the hospital, and more specifically the substitution of powdered latex gloves with less-powdered/powder-free low protein gloves. Other previous (20,21) and recent (23–25) South African studies conducted among HWs reported prevalence of NRL sensitisation to range between 5% and 20.8%. Despite the lower frequency of NRL sensitisation in this study, 12% of HWs reported a history of NRL-related symptoms, but no significant differences were observed between the two hospitals. However, SAHWs (4%) were significantly (p=0.003) more likely to be diagnosed with NRL allergy, compared to their Tanzanian counterparts (1%).

In this current study, pulmonary function tests revealed significantly lower lung volumes among Tanzanian HWs compared to their South African counterparts even after poor quality spirograms were excluded. Furthermore, there was no correlation between the poor quality of spirometry and the presence of respiratory symptoms. One possible explanation for this finding is the high frequency of repeated childhood chest infections reported in the Tanzanian HWs. Repeated childhood chest infections has been reported to be a risk factor for the lower adult FEV_1 (56). Another possible explanation for the observed difference is the exposure to biomass fuel. Biomass fuel was used for cooking by most individuals (99.5%) in a recent Tanzanian study (57).

Furthermore, a higher prevalence of airway obstruction was also found in this group of TAHWs. A vigorous literature search was unable to identify any study that has reported on airway obstruction among HWs in Tanzania and hence limiting comparisons with the study findings. However, compared to other Tanzanian workplaces, the prevalence of airways obstruction in this study was similar or lower (58–62). The higher frequency of repeated childhood chest infections reported in the Tanzanian HWs and potential biomass fuel exposure could also explain the higher prevalence of airways obstruction among TAHWs.

The higher prevalence of significant bronchial reversibility observed (Table 5.7) among SAHWs (28%) compared to TAHWs (10%) is mainly because of the selective nature of the SAHWs who performed pre- and post-BD spirometry. This was evidenced by the fact that a significantly higher proportion of SAHWs who performed pre- and post-BD spirometry (24%) reported history of asthma compared to those who conducted MCT (7%) (p=0.009). Moreover, SAHWs who performed pre- and post-BD spirometry had significantly lower FEV_1 compared to those who conducted MCT (p<0.001) and hence more likely to obtain significant bronchial reversibility. On the other hand, the higher prevalence of non-specific bronchial hyper-responsiveness (NSBH) observed among the SAHWs could be explained by the use of a more sensitive test (MCT), compared to the pre- and post-BD spirometry used in the TAH.

In the current study, FeNO levels were comparable to the other workplace-based studies in Tanzania and South Africa in non-health care settings (54,61,63–65). While, the median FeNO levels in the current study (17 ppb) were similar to supermarket bakery workers (median = 15 ppb), cement factory workers (median = 15 ppb) and coffee factory workers (geometric mean = 17.4 ppb) (61,63,64), the prevalence of high FeNO (>50 ppb) in the current study (6%) indicative of allergic airway inflammation, was much lower than previous South African studies of workers exposed to predominantly high molecular weight protein agents (poultry farm: 7%, spice mill: 8%, supermarket bakeries: 11%) (54,63,65). This suggest that the work-related asthma reported in this current group of workers to have both allergic and non-allergic components, requiring further investigation (2,66).

To the best of our knowledge, this is the first study in southern Africa of HWs exposed to cleaning agents and the first globally to have undertaken an extensive epidemiological study on the immunological assessment of HWs to OPA and chlorhexidine. Previous studies by Fujita *et al*. (8) and Miyajima *et al*. (9), reported only on work-related symptoms and did not provide more objective measures of work-related allergy and asthma as the current study. To the knowledge of investigators, this is the first epidemiological study in southern Africa to have conducted FeNO measurements in HWs. Furthermore, this is also the first epidemiological study on the immunological assessment of HWs sensitized to NRL in Tanzania. Despite these strengths, there are some limitations in obtaining a detailed immunological assessment of the Tanzanian group. Immunological assessment of sensitisation to glutaraldehyde was not done due to the lack of commercially available immunoCAP for glutaraldehyde. This is important since glutaraldehyde continue to be used as a high-level disinfectant in the TAH. Furthermore, methacholine challenge tests could not be conducted in the TAH due to logistical reasons. Hence, a more composite picture of HWs in this hospital could not be obtained compared to their South African counterparts. Nevertheless, the study has provided important insight into work-related asthma in sub-Saharan HWs exposed to OPA and NRL. Furthermore, while some of the factors that could potentially explain the differences in outcome prevalence between the two hospitals such as socio-economic status were not assessed, other factors such as age, gender, smoking status and body mass index were not able to explain the differences observed in the outcome prevalence. Additionally, since health outcome status of non-respondents was not known, the possibility of sampling bias affecting the results cannot be ruled out given the response rate (average: 53%) obtained in this study.

5.5. CONCLUSION

This study has demonstrated that HWs in these two hospitals experience an appreciable proportion of work-related airway and skin symptoms. However, South African HWs experienced higher prevalence of work-related skin symptoms as compared to the Tanzanian HWs, possibly due to their higher frequency of hand washing. Tanzanian HWs had comparatively higher proportion of individuals with decreased lung volumes and airflow obstruction. The study has also shown that the prevalence of NRL sensitisation is declining in South Africa most likely due to the NRL preventive measures implemented, particularly the substitution of powdered latex gloves with less-powdered/powder-free gloves.

5.6. REFERENCES

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Chapter 6

Asthma phenotypes and host risk factors associated with various asthma-related outcomes among health workers

ABSTRACT

Background: Asthma is a heterogeneous disease with diverse clinical, physiological and inflammatory characteristics. A few studies have characterised occupational asthma phenotypes mainly based on its aetiology, be it high molecular weight (HMW) and low molecular weight (LMW) agents. However, little is known about the pattern of asthma phenotypes in health workers (HWs) exposed to cleaning agents. Differentiating between various asthma phenotypes in the workplace is important in understanding the heterogeneous nature of the disease in order to develop appropriate management and preventive strategies. This study was conducted to describe various asthma phenotypes in HWs exposed to cleaning agents and to identify important host risk factors associated with various asthma phenotypes based on symptoms, presence of non-specific bronchial hyperresponsiveness and allergic airway inflammation.

Methods: A cross-sectional study of 699 HWs was conducted in two large tertiary hospitals. A total of 697 participants completed questionnaire interviews. Sera was collected from 682 HWs and analysed for specific immunoglobulin E (sIgE) antibody reactivity to common aero-allergens (Phadiatop) and specific occupational allergens (NRL - *Hevea brasiliensis* (Hev b5, Hev b6.02), chlorhexidine and OPA). Methacholine challenge tests (MCT) were performed on all South African HWs (n=318), based on standard inclusion criteria. Spirometry, accompanied by a post-bronchodilator (post-BD) test was conducted on all Tanzanian HWs (n=329) and a small proportion (n=25) of South African HWs (SAHWs) where MCT was contraindicated. All HWs from both hospitals (n= 654) underwent fractional exhaled nitric oxide (FeNO) testing during the working day prior to spirometry. An asthma symptom score was computed based on the sum of answers to five questions on asthma-related symptoms in the past 12 months. Current asthma was defined as either having an asthma attack in the past 12 months, current use of asthma medication or woken up by an attack of shortness of breath in the past 12 months. Nonspecific bronchial hyperresponsiveness (NSBH) was defined as either positive MCT (PD_{20} methacholine < 0.4 mg) or presence of a significant bronchodilator response - BDR (≥12% and ≥ 200 ml increase in FEV_1 after administration of a bronchodilator). Two continuous indices of NSBH (continuous index of responsiveness (CIR) and dose-response slope (DRS)) were also calculated.

Results: The prevalence of current asthma was 10% with atopic asthma (6%) more prevalent than non-atopic asthma (4%). Overall, there were 2% of subjects with work-related asthma. There was a weak positive correlation between NSBH (CIR: Beta coefficient (β) = 0.12; 95% Confidence Interval (CI): 0.03 – 0.22 and DRS: β = 0.07; 95% CI: 0.03 – 0.12) and FeNO. Combining FeNO ≥ 50 ppb with post-BD spirometry test (mean ratio (MR) = 5.89; 95% CI: 1.02 – 34.14) or with NSBH (MR = 4.62; 95% CI: 1.16 – 18.46) correlated better with asthma symptom score than either of them individually (FeNO ≥ 50 ppb: MR = 2.23; 95% CI: 1.30 – 3.85). Participants with current asthma were more likely to be atopic (odds ratio (OR) = 2.04; 95% CI: 1.23 – 3.39), have a family history of allergy (OR = 2.25; 95% CI: 1.32 – 3.82) and a history of hay fever (OR = 2.30; 95% CI: 1.38 – 3.83). Furthermore, FeNO ≥ 50 ppb was positively associated with atopy (OR = 3.19; 95% CI: 1.59 – 6.39) and a history of hay fever (OR = 2.05; 95% CI: 1.08 – 3.93). The majority of HWs who were sensitised to occupational allergens (OPA, chlorhexidine and NRL) were atopic.

Conclusion: This study has demonstrated that atopic asthma was more prevalent than non-atopic asthma. Furthermore, most asthma-related outcomes and work-related symptoms were positively associated with allergic predictors suggesting a more dominant role of allergic mechanisms in asthma and work-related symptoms experienced by these HWs. Stronger associations observed for asthma symptoms when high FeNO (≥ 50 ppb) was combined with NSBH (BDR + MCT), together with the finding that atopic individuals displayed an increased risk of sensitisation to OPA and chlorhexidine, further suggests an IgE mediated mechanism for the asthma reported in this group of HWs.

6.1. INTRODUCTION

Asthma is a heterogeneous disease with diverse clinical, physiological and inflammatory characteristics (1–3). A number of studies have reported various phenotypes for non-work-related asthma, with significant efforts directed towards characterising the severe asthma phenotypes (2,3). However, studies that have investigated occupational asthma phenotypes are quite limited and most of them have only characterised occupational asthma based on its aetiological agent, viz., high molecular weight and low molecular weight agents (1,4,5). The published literature on asthma phenotypes in health workers (HWs) exposed to cleaning agents is even more scant (6). Differentiating between various asthma phenotypes in the workplace is important in understanding the heterogeneous nature of the disease so as to develop appropriate management and preventive strategies (1,5).

Few epidemiological studies have investigated the magnitude of asthma among HWs. In an international prospective population-based study [European Community Respiratory Health Survey-II (ECRHS-II)], the prevalence of new-onset asthma (asthma attack or taking asthma medication in the past 12 months) among nurses was reported to be 4.8% (7). A more detailed analysis of HWs from this study (8) reported a slightly higher prevalence of new-onset asthma (currently taking asthma medication, asthma attack or woken up by an attack of shortness of breath in last 12 months) of 6%, most likely due to the different asthma definitions used. These findings are similar to a US study of HWs (n=3650) with active professional licenses (9), which demonstrated an overall prevalence of doctor-diagnosed asthma with onset after entry into the healthcare profession of 6.6%. In this study (9), the highest prevalence was among nurses (7.3%) followed by respiratory therapists (5.6%), occupational therapists (4.5%) and doctors (4.2%). However, a study published 2 years later from the same US population of HWs reported a much higher prevalence (9.8%) of doctor diagnosed asthma with onset after entry into the healthcare profession among nurses based on their longest job held (10).

In a South African population-based study of adults (11), the prevalence of recent wheeze was higher (16.3%) than actual asthma diagnosis (3.8%) and asthma medication usage (8.6%). Little is known about the magnitude of asthma specifically in HWs of general health facilities in South Africa. However, a recent study of dental HWs (12) reported a 6.9% prevalence of atopic asthma, while a slightly lower proportion (5.9%) had non-atopic asthma. In this occupational group, work-exacerbated asthma was reported in 4% of the study population. In contrast, previous studies of the general population in Tanzania reported a much lower prevalence of asthma between 3.3% and 3.5% (13,14). However, the prevalence of asthma specifically among HWs in Tanzania is unknown.

Various studies have investigated the host-associated risk factors in adult asthma. Common host risk factors that have been associated with asthma include age, gender, seniority, smoking status and atopy (9,10). A previous study by Kogevinas *et al.* (7) of workers across different industries, demonstrated that atopic individuals had a significantly higher risk for new-onset asthma than non-atopics. The study also demonstrated an increased risk of new-onset asthma in those with a parental history of asthma and among non-smokers compared to current smokers. More recently, risk factors for non work-related adult-onset asthma and occupational asthma have also been reviewed in a comparative manner (1). This review found that while host associated factors (e.g age, gender, genetics, atopy and obesity) did not differ for these two broad asthma phenotypes, environmental factors appeared to play a very important role in occupational asthma. Rava *et al*. have also (15) identified novel genes involved in adult asthma related to occupational exposure to LMW agents / irritants in three large European cohorts of general population.

Among HWs, women appear to be more affected than men. The US study (16) of HWs by Arif *et al*., demonstrated women to have a higher prevalence of all asthma phenotypes, including WRA symptoms (3.6% vs 1.8%), work-exacerbated asthma (1.3% vs 0.3%) and occupational asthma (1.0% vs 0.1%) than men. Similar findings were reported in a large population European study (7) that found a slightly higher relative risk of new-onset asthma among women compared to men. It is likely that the gendered distribution of work plays an important role.

The aim of this study was to describe various asthma phenotypes and to determine host risk factors associated with these phenotypes in a group of HWs from two large tertiary academic hospitals in sub-Saharan Africa.

6.2. METHODS

6.2.1. Study design, Population and Sampling

A cross-sectional study of **699** HWs was conducted in two large tertiary academic hospitals (**346** from a South Africa hospital – SAH and **353** from Tanzanian hospital - TAH). All permanently employed HWs in the high-risk departments, as previously described (Chapter 3), constituted the sampling frame of the study. Doctors were excluded from the sampling frame as they were more likely to work in multiple different exposure settings across the hospital. A list of all permanently employed HWs in the high-risk departments of both hospitals was obtained from their respective managers. Study participants were selected from these departments through stratified random sampling according to job title, choosing up to five HWs from each high-risk department. For departments having more than five HWs with the same job title, a random sample of five workers was selected. For departments having less than five workers, all workers were selected to participate in the study. Ethics approval was obtained from the Human Research Ethics Committee (HREC) of the University of Cape Town (HREC Ref: 212/2013), Muhimbili University of Health and Allied Sciences (MUHAS) Institutional Review Board and University of Michigan Medical School Institutional Review Board (HUM00083115).

6.2.2. Questionnaire

A total of **697** participants completed the questionnaire interviews (**344** from SAH and **353** from TAH). Each participant answered a modified questionnaire for the investigation of asthma as contained in the Protocol for the European Community Respiratory Health Survey (17). The study questionnaire also included validated questions from the NIOSH specific questionnaire for cleaning agents in the health care setting (18). The questionnaire was administered by trained interviewers in English language for South African health workers (SAHWs) and in Swahili language for Tanzanian health workers (TAHWs). The translated Swahili questionnaire was back-translated to ensure validity and repeatability.

6.2.3. Immunological assessment

Blood samples were collected from **682** participants (**339** SAHWs and **343** TAHWs). Specific IgE antibody reactivity to common aero-allergens (Phadiatop) and specific occupational allergens was evaluated. The quantification of specific IgE antibodies to specific occupational allergens: NRL (*Hevea brasiliensis* - Hev b5, Hev b6.02), chlorhexidine and OPA was performed using the UniCAP system (Phadia, Uppsala, Sweden). Immunological assessment for chlorhexidine was only done on sera of SAHWs since chlorhexidine containing chemicals were not used in the TAH.

Commercial ImmunoCAPs containing Phadiatop (Phad), Chlorhexidine (C8), rHev b5 (K218) and rHev b6.02 (K220) allergens were obtained from Thermo Scientific. Since the OPA test was not readily available commercially, it required further development as previously described (Chapter 3). Serum samples were tested at the National Institute for Occupational Health (NIOH) Immunology laboratory using the UNICAP 250 machine supplied by Thermo Scientific according to the manufacturer's manual.

6.2.4. Spirometry (pre and post-bronchodilator)

There were **328** participants from the TAH and **25** participants from the SAH who performed spirometry (pre- and post-bronchodilator). The latter group did not proceed to methacholine challenge testing (see below) due to contra-indications (e.g. FEV_1 below 1.5 litres or 70% predicted, pregnant and breastfeeding women). Spirometry was conducted according to guidelines of the American Thoracic Society/European Respiratory Society (ATS/ERS) (19) using EasyOne World spirometer (ndd Medical Technologies, Zurich, Switzerland) at the TAH and Jaeger Aerosol Provocation System (APS) Pro apparatus at the SAH according to the manufacturer's instructions as previously described.

6.2.5. Methacholine challenge tests

Methacholine challenge testing (MCT) was only performed in the South African study site due to logistical considerations. The tests were conducted in a pulmonary function laboratory that was well equipped with appropriate resuscitation facilities. Among **318** participants who underwent spirometry, **239** performed interpretable PD_{20} methacholine results while **52** participants had ≥10% decrease in FEV_1 after administration of saline diluent and were therefore not considered for MCT. MCT was discontinued in **two** participants who requested the test to be stopped. As explained above, **25** participants underwent post-bronchodilator spirometry, since MCT was contraindicated. MCT was conducted under the supervision of an experienced technologist according to an abbreviated protocol used in epidemiological surveys. The Medic Aid Pro Nebulizer dosimeter method involved a protocol of increasing numbers of breaths to achieve pre-defined cumulative doses of methacholine (20). The doses were delivered by the Jaeger APS MedicAid Side Stream APS-Nebulizer according to the manufacturer's instructions, commencing with the lowest dose of 0.026 mg. The dose was increased to a maximum of 2.048 mg methacholine if a positive endpoint (fall in FEV_1 of 20% or more) was not obtained. The results of the MCT were interpreted as follows: borderline defined as 0.4mg $<PD_{20}M<1.0$ mg; mild = 0.08 mg $< PD_{20}M <0.4$mg; moderate/severe = $PD_{20}M< 0.08$mg. Borderline values for $PD_{20}M$ were considered negative in the definition of non-specific bronchial hyper responsiveness (NSBH) as previously described.

6.2.6. Fractional exhaled nitric oxide (FeNO)

A total of **654** participants performed FeNO tests (**334** from SAH and **320** from TAH). A hand-held portable exhaled nitric oxide sampling device (NIOX MINO® Airway Inflammation Monitor (NIOX MINO); Aerocrine AB, Solna, Sweden) was used according to the manufacturer's instructions. Two technically adequate measurements were performed in line with the current American Thoracic Society /European Respiratory Society recommendations (21). A third maneuver was performed if the difference between the first two measurements was more than 10 ppb. The FeNO test was done during the work shift before spirometry / MCT.

6.2.7. Operational definitions of asthma phenotypes and host-associated risk factors

Information on which the asthma phenotypes were based was obtained from the modified ECRHS questionnaire, immunological tests, spirometry (pre- and post-bronchodilator), methacholine challenge tests and FeNO levels.

An asthma symptom score was computed based on the sum of answers (0=no, 1=yes) to five questions reported in the past 12 months. These included the presence of shortness of breath while wheezing; being woken up with chest tightness; an attack of shortness of breath at rest; an attack of shortness of breath after exercise; and being woken up by an attack of shortness of breath, as has been described in previous studies (22–25). A binary variable was created from these five asthma-related symptoms (≥ 2 symptoms vs 0-1 symptom). Having ≥ 2 asthma-related symptoms was considered 'more symptomatic' and 0-1 symptom as 'less symptomatic'.

Individuals with sensitization to specific occupational allergens were identified based on sIgE ≥ 0.35 KU/L. A variable was created for sensitisation to at least one occupational allergen (OPA, Chlorhexidine or NRL).

A categorical variable for NSBH was defined as any of the following two criteria: positive methacholine challenge test (PD_{20} methacholine < 0.4 mg) or significant bronchodilator response (≥12% and ≥ 200 ml increase in FEV_1 after administration of a bronchodilator).

Two continuous indices of MCT (continuous index of responsiveness (CIR) and dose-response slope (DRS)) were also calculated (26). CIR = (Post-diluent FEV_1 – FEV_1 at the last dose of methacholine) ÷ Post-diluent FEV_1 and DRS = (Post-diluent FEV_1 – FEV_1 at the last dose of methacholine) ÷ (Post-diluent FEV_1 x Last methacholine dose). CIR and DRS were all multiplied by 100 to convert them into percentages.

FeNO results were interpreted as follows: low < 25ppb; elevated for values 25 - 50ppb; and high for values > 50ppb, the last mentioned is generally considered to signify the presence of allergic airway inflammation (27). In addition to FeNO being analysed as a continuous variable, two categorical variables (FeNO ≥ 25 ppb and FeNO ≥ 50 ppb) were also computed to gain more specificity in the analysis.

In order to further characterise the asthma phenotypes, various definitions were employed in the analysis. *Current asthma* was defined as either having an asthma attack in the past 12 months, current use of asthma medication or woken up by an attack of shortness of breath in the past 12 months (8,24,28). *Atopic asthma* was defined as either having an asthma attack in the past 12 months, current use of asthma medication or woken up by an attack of shortness of breath in the past 12 months; and presence of atopy. *Nonatopic asthma* was defined as either having an asthma attack in the past 12 months, current use of asthma medication or woken up by an attack of shortness of breath in the past 12 months; and being nonatopic. *Work-related asthma* was defined as either having an asthma attack in the past 12 months, current use of asthma medication or woken up by an attack of shortness of breath in the past 12 months; and work-related chest symptoms in the past 12 months that gets better when away from work or worsen on return to work.

Further information on the host-associated risk factors was based on information obtained from the questionnaire and immunological tests (for atopy). Body mass index (BMI) was calculated as weight in kilograms divided by height in metres squared. Two categorical variables were created for smoking history. One was a binary variable: ever smokers (current smokers and ex-smokers) vs never smokers. The second smoking variable was a nominal variable with three categories (current smokers, ex-smokers and never smokers). A family history of allergy was defined as a positive answer to the question "do or did any member of your family (blood relatives) ever have any kind of allergies?". Individuals with atopy were defined as those subjects having a positive Phadiatop test. Hay-fever was defined as a positive response to the question "have you ever had any nose or eye problems or allergies such as hay fever?". Childhood-onset asthma was defined as doctor-diagnosed asthma at the age of 16 years or younger. Adult-onset asthma was defined as doctor-diagnosed asthma at the age of 17 years or older. Frequency of domestic cleaning was categorised as ≥1 day/week vs <1 day/week. All these items were obtained from the questionnaire responses.

6.2.8. Statistical analysis

All data analysis was performed using statistical software STATA version 14 (StataCorp, College Station, Texas, USA). Frequencies of categorical variables were compared between the two hospitals using chi-squared test. Numerical variables were summarised using median and interquartile range, since not all variables followed a normal distribution. Numerical variables were compared between the two hospitals using Wilcoxon sum rank test. Scatter plots, Spearman rank correlational analysis (for non-normally distributed) and unadjusted linear regression models were used to assess association between numerical variables (CIR, DRS and FeNO). Continuous indices of MCT (CIR and DRS) and FeNO were log transformed (natural log) before linear regression analysis was conducted.

After conducting univariate and bivariate analyses, unadjusted logistic and linear regression models were run to test the association between health outcomes (e.g. asthma-related symptoms, NSBH, FeNO, current asthma, atopic asthma, non-atopic asthma, work-related asthma) and host-related risk factors (e.g. age, gender, BMI, atopy). A negative binomial regression analysis was used for the association between asthma symptom score (a count outcome variable) and host-related risk factors. The results of negative binomial regression models were reported as mean ratios with 95% confidence intervals.

6.3. RESULTS

6.3.1. Asthma phenotypes

The overall prevalence of current asthma was 10% with atopic asthma (6%) being slightly more prevalent than non-atopic asthma (4%) (Table 6.1). Overall, there were 2% of subjects with work-related asthma. While the prevalence of atopic asthma was slightly higher in the SAH, the prevalence of non-atopic asthma was similar in both settings. Similarly, the prevalence of work-related asthma was higher in the Tanzanian (3%) than the South African (2%) academic hospital, but these were also not statistically significant different.

Table 6.1: Prevalence of asthma-related outcomes among health workers in the tertiary hospitals

	Overall	Tertiary Hospital - South Africa N (%)	Tertiary Hospital - Tanzania N (%)	p-value (Chi-squared test)
Participants (n)	**697**	**344**	**353**	
Asthma symptom score				
0	478 (69)	190 (55)	288 (82)	<0.001
1	128 (18)	96 (28)	32 (9)	
2	42 (6)	31 (9)	11 (3)	
3	17 (2)	11 (3)	6 (2)	
4	18 (3)	10 (3)	8 (2)	
5	14 (2)	6 (2)	8 (2)	
Asthma history				
Doctor-diagnosed asthma	48 (7)	29 (8)	19 (5)	0.112
Current use of asthma medication	39 (6)	21 (6)	18 (5)	0.564
Asthma attack in the past 12 months	31 (5)	16 (5)	15 (4)	0.797
Woken up by an attack of shortness of breath in the last 12 months	48 (7)	26 (8)	22 (6)	0.503
Current use of asthma medication OR asthma attack in the past 12 months	44 (6)	24 (7)	20 (6)	0.477
Work-related symptoms				
Work-related chest symptoms in the past 12 months	48 (7)	20 (6)	28 (8)	0.270
Work-related ocular–nasal symptoms in the past 12 months	109 (16)	48 (14)	61 (17)	0.227
Atopy	296 (43)	160 (47)	136 (40)	0.047
Bronchial hyperresponsiveness				
Positive Bronchodilator response (BDR): ≥12% and ≥200 ml FEV_1 increase post-bronchodilator	**n = 207**	**n = 25**	**n = 182**	NA
	26 (13)	7 (28)	19 (10)	
Methacholine challenge test: PD_{20} methacholine < 0.4 mg (n = 239)	NA	31 (13)	ND	NA
NSBH#	**n = 446**	**n = 264**	**n = 182**	NA
	57 (13)	38 (14)	19 (10)	
Fractional exhaled nitric oxide (FeNO)	**n = 654**	**n = 334**	**n = 320**	
FeNO (ppb) [median (IQR)]	17 (11 – 24)	17 (12 – 25)	15 (10 – 22)	0.003*
≥25 ppb	150 (23)	83 (25)	67 (21)	0.234
≥50 ppb	41 (6)	23 (7)	18 (6)	0.506
Asthma phenotypes				
Current asthma	69 (10)	37 (11)	32 (9)	0.455
Atopic asthma	41 (6)	22 (6)	19 (5)	0.583
Non-atopic asthma	28 (4)	15 (4)	13 (4)	0.660
Work-related asthma	17 (2)	8 (2)	9 (3)	0.848

FEV_1: forced expiratory volume in 1 second; PD_{20} methacholine: provocative dose of methacholine causing a ≥ 20% fall in FEV_1; NSBH: nonspecific bronchial hyperresponsiveness; #: NSBH defined as any of the following two criteria: PD_{20} methacholine < 0.4 mg ***OR*** a positive BDR defined as ≥12% and ≥ 200 ml increase in FEV_1 after administration of a bronchodilator; *: Wilcoxon sum rank test; ND: Not done; NA: Not applicable; IQR: interquartile range

6.3.2. Association between FeNO and/or NSBH and asthma symptoms

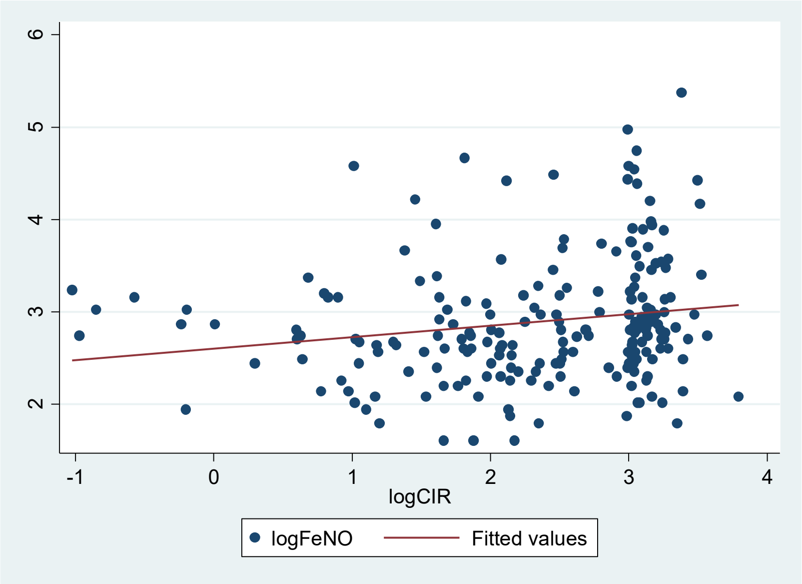
There was a statistically significant weak positive correlation between continuous indices of bronchial hyperresponsiveness (CIR: Beta coefficient (β) = 0.12; 95% Confidence Interval (CI): 0.03 – 0.22 and DRS: β = 0.07; 95% CI: 0.03 – 0.12) and FeNO (Table 6.2). A similar pattern was observed between bronchial hyperresponsiveness (CIR: Odds ratio (OR) = 1.65; 95% CI: 1.10 – 2.47 and DRS: OR = 1.25; 95% CI: 1.06 – 1.47) and FeNO ≥25 ppb. However, only 3-5% of the variability in bronchial hyperresponsiveness could explain the FeNO levels. Further analysis found that levels of FeNO ≥ 50 ppb coupled with either a positive BDR (mean ratio (MR) = 5.89; 95% CI: 1.02 – 34.14) or increased NSBH (MR = 4.62; 95% CI: 1.16 – 18.46) was more strongly associated with asthma symptoms than FeNO on its own (FeNO ≥ 50 ppb: MR = 2.23; 95% CI: 1.30 – 3.85) (Table 6.3). Furthermore, an asthma symptom score ≥2 appeared to be a better discriminator of asthma symptoms than the presence of any asthma symptom. This formed the basis for further investigation of these outcomes with the host risk factors of interest.

Table 6.2: Association between continuous indices of bronchial hyperresponsiveness and FeNO in South African health workers

	FeNO			
	FeNO, ppb #		**FeNO ≥25 ppb**	**FeNO ≥50 ppb**
	Beta coefficient (95% CI)	**R^2**	**Odds ratio (95% CI)**	
Continuous index of responsiveness (CIR)#	**0.12 (0.03 – 0.22)***	0.03	**1.65 (1.10 – 2.47)***	1.69 (0.88 – 3.27)
Dose-response slope (DRS)#	**0.07 (0.03 – 0.12)****	0.05	**1.25 (1.06 – 1.47)****	1.18 (0.93 – 1.50)

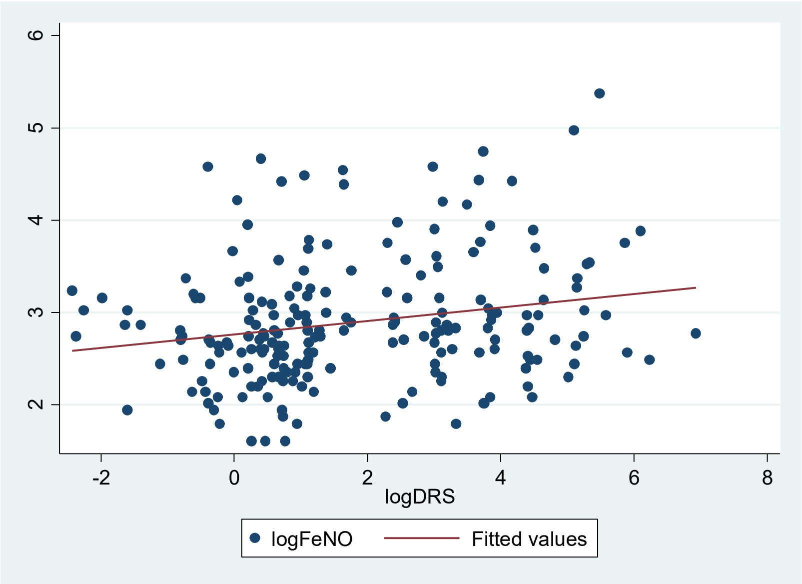
Each odds ratio/Beta coefficient represents a separate unadjusted regression model; CI: Confidence Interval; #: natural log-transformed values;*: p-value < 0.05; **: p-value < 0.01

Figure 6.1: Scatter plot demonstrating the association between continuous index of responsiveness (CIR) and FeNO in South African health workers



Spearman rank correlation coefficient = 0.20 (p-value = 0.003)

Figure 6.2: Scatter plot demonstrating the association between dose-response slope (DRS) and FeNO in South African health workers



Spearman rank correlation coefficient = 0.20 (p-value = 0.004)

Table 6.3: Association between FeNO and/or bronchial hyperresponsiveness and asthma symptoms among health workers in the tertiary hospitals

	Prevalence: n (%)	Asthma symptoms	
		Asthma symptom score	**Asthma symptom score (≥2 vs 0-1)**
		MR (95% CI)	**OR (95% CI)**
Prevalence: n (%)			91 (13)
FeNO ≥ 25 ppb (n = 654)	150 (23)	**1.53 (1.09 – 2.16)***	1.61 (0.97 – 2.66)
FeNO ≥ 50 ppb (n = 654)	39 (6)	**2.23 (1.30 – 3.85)****	**3.10 (1.51 – 6.34)****
Positive BDR (n = 207) [¶]	26 (13)	0.87 (0.27 – 2.78)	0.55 (0.12 – 2.46)
$PD_{20}M$ < 0.4 mg (n = 239) [#]	31 (13)	1.26 (0.76 – 2.08)	1.54 (0.62 – 3.82)
NSBH (n = 446)	57 (13)	1.17 (0.71 – 1.94)	1.16 (0.54 – 2.50)
FeNO and/or positive BDR (n=662)			
FeNO ≥ 25 ppb OR positive BDR	168 (25)	1.31 (0.94 – 1.83)	1.32 (0.80 – 2.17)
FeNO ≥ 25 ppb AND positive BDR	8 (1)	2.42 (0.74 – 7.90)	2.25 (0.45 – 11.35)
FeNO ≥ 50 ppb OR positive BDR	62 (9)	1.45 (0.89 – 2.36)	1.70 (0.87 – 3.34)
FeNO ≥ 50 ppb AND positive BDR	3 (1)	**5.89 (1.02 – 34.14)***	**13.64 (1.22 – 152.11)***
FeNO and/or $PD_{20}M$ < 0.4 mg[#] (n = 337)			
FeNO ≥ 25 ppb OR $PD_{20}M$ < 0.4 mg	103 (31)	1.25 (0.90 – 1.75)	1.31 (0.72 – 2.40)
FeNO ≥ 25 ppb AND $PD_{20}M$ < 0.4 mg	11 (3)	1.47 (0.66 – 3.29)	1.92 (0.49 – 7.47)
FeNO ≥ 50 ppb OR $PD_{20}M$ < 0.4 mg	51 (15)	**1.52 (1.01 – 2.28)***	**2.18 (1.09 – 4.38)***
FeNO ≥ 50 ppb AND $PD_{20}M$ < 0.4 mg	2 (1)	2.01 (0.36 – 11.20)	5.06 (0.31 – 82.04)
FeNO and/or NSBH (n=665)			
FeNO ≥ 25 ppb OR NSBH	188 (28)	1.38 (1.00 – 1.90)	1.42 (0.88 – 2.30)
FeNO ≥ 25 ppb AND NSBH	19 (3)	2.17 (0.99 – 4.75)	2.48 (0.87 – 7.08)
FeNO ≥ 50 ppb OR NSBH	91 (14)	**1.56 (1.04 – 2.34)***	**1.83 (1.03 – 3.25)***
FeNO ≥ 50 ppb AND NSBH	5 (1)	**4.62 (1.16 – 18.46)***	**10.39 (1.71 – 63.11)***

[#]: South African HCWs only; [¶]: ≥12% and ≥200 ml FEV_1 increase post-bronchodilator; MR: mean ratio; OR: odds ratio; CI: confidence interval; FEV_1: forced expiratory volume in 1 second; $PD_{20}M$: provocative dose of methacholine causing a ≥ 20% fall in FEV1; NSBH: nonspecific bronchial hyperresponsiveness; NSBH defined as any of the following two criteria: $PD_{20}M$ < 0.4 mg OR positive BDR: ≥12% and ≥ 200 ml increase in FEV1 after administration of a bronchodilator; *: p-value < 0.05; **: p-value < 0.01; Each OR represents a separate unadjusted regression model

6.3.3. Host risk factors associated with respiratory symptoms

In the exploration of demographic host risk factors (Table 6.4), higher mean asthma symptom scores were more likely to be observed in females (mean ratio (MR) = 2.03; 95% CI: 1.37 – 3.00), those with a higher BMI (MR = 1.04; 95% CI: 1.02 – 1.06), atopic individuals (MR = 1.74; 95% CI: 1.30 – 2.33), with family history of allergy (MR = 2.11; 95% CI: 1.58 – 2.82) and a past history of hay fever (MR = 2.61; 95% CI: 1.97 – 3.47) and they were more likely to have suffered from chronic bronchitis (MR = 2.79; 95% CI: 1.69 – 4.60) and pulmonary tuberculosis (PTB) (MR = 2.21; 95% CI: 1.21 - 4.06). In addition, participants who were more symptomatic (≥ 2 asthma-related symptoms) were more likely to have ever smoked (OR = 1.99; 95% CI: 1.13 – 3.49), when compared to those who were less symptomatic (0 – 1 asthma-related symptom).

Workers with work-related ocular-nasal symptoms (WRONS) in the past 12 months had an 8-fold increased odds (OR = 8.16; 95% CI: 4.84 – 13.76) of past history of hay fever. Participants with work-related asthma symptoms (WRAS) in the past 12 months were also more likely to be females (OR = 3.25; 95% CI: 1.15 – 9.19), have a previous history of hay fever (OR = 3.03; 95% CI: 1.61 – 5.69) or PTB (OR = 4.26; 95% CI: 1.74 – 10.44) and were also more likely to have had adult-onset asthma (OR = 10.42; 95% CI: 4.59 – 23.67).

Table 6.4: Host risk factors associated with respiratory symptoms among health workers in the tertiary hospitals

	Prevalence: n (%)	**Asthma symptom score##**	**Asthma symptom score (≥2 vs 0-1)**	**WRONS**	**WRAS**
Prevalence: n (%) (n = 697)			91 (13)	109 (16)	48 (7)
Demographic characteristics					
Age		1.01 (1.00 – 1.03)	**1.02 (1.00 – 1.04)***	0.99 (0.97- 1.01)	1.00 (0.97 – 1.03)
Gender (Females vs Males):		**2.03 (1.37 – 3.00)*****	**1.98 (1.05 - 3.74)***	1.12 (0.68– 1.86)	**3.25 (1.15 – 9.19)***
BMI		**1.04 (1.02 – 1.06)****	**1.04 (1.01 – 1.08)****	0.99 (0.96– 1.02)	1.00 (0.96 – 1.04)
Smoking history					
Smoking (ever) ‡‡	90 (13)	1.48 (0.99 – 2.23)	**1.99 (1.13 – 3.49)***	1.30 (0.74– 2.31)	0.60 (0.21– 1.70)
Current smoking	42 (6)	1.48 (0.83 – 2.63)	1.75 (0.78 – 3.92)	1.75 (0.83 – 3.68)	0.31 (0.04 – 2.32)
Allergy history					
Family history of allergy	353 (51)	**2.11 (1.58 – 2.82)*****	**2.60 (1.61 – 4.19)*****	1.13 (0.75 – 1.70)	1.16 (0.65– 2.10)
Atopy (positive Phadiatop)	296 (43)	**1.74 (1.30 – 2.33)*****	**2.40 (1.52 – 3.79)*****	1.33 (0.88 – 2.02)	1.67 (0.92– 3.02)
Medical history					
Hay fever	306 (44)	**2.61 (1.97 – 3.47)*****	**4.03 (2.47 – 6.56)*****	**8.16 (4.84 - 13.76)*****	**3.03 (1.61 – 5.69)****
Childhood-onset (≤16 yrs) asthma	19 (3)	**4.35 (2.17 - 8.74)*****	**13.00 (4.97 – 33.99)*****	0.63 (0.14 – 2.76)	2.64 (0.74 – 9.39)
Adult-onset (>16 yrs) asthma	29 (4)	**4.57 (2.63 – 7.93)*****	**9.73 (4.51 – 21.02)*****	1.77 (0.74– 4.24)	**10.42 (4.59 – 23.67)*****
Repeated childhood chest infections	76 (11)	1.53 (0.99 – 2.37)	**1.76 (0.96 – 3.26)**	1.66 (0.93– 2.97)	1.71 (0.77– 3.80)
Chronic bronchitis	44 (6)	**2.79 (1.69 – 4.60)*****	**3.49 (1.77 – 6.87)*****	1.89 (0.92 – 3.86)	2.30 (0.92– 5.74)
Pulmonary tuberculosis	32 (5)	**2.21 (1.21 - 4.06)***	**4.45 (2.10 – 9.45)*****	1.26 (0.51– 3.14)	**4.26 (1.74 – 10.44)****
Domestic chemical exposures					
Home cleaning in the past 12 months (≥1 day vs <1 day/week)	601 (86)	1.54 (0.98 – 2.44)	1.76 (0.82 – 3.77)	0.92 (0.51 – 1.64)	1.40 (0.54 – 3.64)
Use of sprays for home cleaning in the past 12 months (≥1 day vs <1 day/week)	218 (31)	**1.47 (1.08 – 1.99)***	1.37 (0.87 – 2.16)	0.90 (0.57 – 1.41)	0.81 (0.42 – 1.55)

Data are presented as OR (95% CI), unless otherwise indicated. ##: MR (95% CI); OR: odds ratio; CI: confidence interval; MR: mean ratio; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001; ‡‡: current & ex-smokers vs never smokers; WRONS: Work-related ocular–nasal symptoms (ocular–nasal symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; WRAS: Work-related asthma symptoms (asthma symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; Each OR represents a separate unadjusted regression model

6.3.4. Host risk factors associated with allergic sensitisation to occupational allergens

All (except one) of the study participants who were sensitised to either one of the occupational allergens (OPA, chlorhexidine and NRL) were atopic. Individuals sensitised to OPA were more likely to have lower BMI (OR = 0.92; 95% CI: 0.86 – 0.99) (Table 6.5). Participants who were sensitised to at least one occupational allergen (OPA, NRL or chlorhexidine) had a 2-fold increased odds (OR = 2.09; 95% CI: 1.03 – 4.24) of having medical history of hay fever.

Table 6.5: Host risk factors associated with allergic sensitisation to occupational allergens among health workers in the tertiary hospitals

	Prevalence: n (%)	**Sensitisation to OPA**	**Sensitisation to at least one occupational allergen**
Prevalence: n (%) (n = 682)		26 (4)	34 (5)
Demographic characteristics			
Age		0.98 (0.94 – 1.01)	0.98 (0.95 – 1.02)
Gender (Females vs Males)		1.53 (0.52– 4.52)	1.06 (0.45 – 2.49)
BMI		**0.92 (0.86 – 0.99)***	0.95 (0.89 – 1.00)
Smoking history			
Smoking (ever) ‡‡	90 (13)	0.26 (0.04– 1.98)	0.90 (0.31 – 2.63)
Current smoking	42 (6)	0.57 (0.08– 4.30)	1.48 (0.43 – 5.08)
Allergy history			
Family history of allergy	353 (51)	1.36 (0.61 –3.00)	1.26 (0.63– 2.52)
Atopy (positive Phadiatop)	296 (43)	**35.52 (4.78 – 263.70)*****	**48.31 (6.57 – 355.39)*****
Medical history			
Hay fever	306 (44)	2.05 (0.92– 4.58)	**2.09 (1.03 – 4.24)***
Childhood-onset (≤16 yrs) asthma	19 (3)	NC	NC
Adult-onset (>16 yrs) asthma	29 (4)	3.15 (0.89 – 11.17)	2.31 (0.66 – 8.04)
Repeated childhood chest infections	76 (11)	1.05 (0.31– 3.60)	0.77 (0.23 – 2.59)
Chronic bronchitis	44 (6)	NC	0.90 (0.21– 3.88)
Pulmonary tuberculosis	32 (5)	0.80 (0.11– 6.13)	1.28 (0.29 – 5.61)
Domestic chemical exposures			
Home cleaning in the past 12 months (≥1 day vs < 1 day/week)	601 (86)	0.89 (0.30– 2.64)	0.94 (0.35 – 2.49)
Use of sprays for home cleaning in the past 12 months (≥1 day vs <1 day/week)	218 (31)	0.80 (0.33 – 1.92)	1.04 (0.50 – 2.18)

Data presented as OR (95% CI); OR: odds ratio; CI: confidence interval; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001; ‡‡: current & ex-smokers vs never smokers; NC: not calculable; Each OR represents a separate unadjusted logistic regression model

6.3.5. Host risk factors associated with bronchial hyperresponsiveness and FeNO

Bronchial hyperresponsiveness (increased DRS) was associated with being female (Geometric mean ratio (GM ratio) = 3.40; 95% CI: 1.72 – 6.73), atopic (GM ratio = 1.83; 95% CI: 1.08 – 3.10), history of hay fever (GM ratio = 2.01; 95% CI: 1.19 – 3.39), childhood-onset asthma (GM ratio = 9.01; 95% CI: 1.59 – 50.93) and chronic bronchitis (GM ratio = 2.61; 95% CI: 1.20 – 5.67) (Table 6.6). Participants with NSBH were twice as likely (OR = 2.41; 95% CI: 1.07 – 5.42) to have history of chronic bronchitis as those without NSBH. Atopy (GM ratio = 1.38; 95% CI: 1.25 – 1.52), history of hay fever (GM ratio = 1.16; 95% CI: 1.05 – 1.28) and childhood-onset asthma (GM ratio = 1.49; 95% CI: (1.11 – 1.99) were associated with increased FeNO. On the other hand, current smoking (GM ratio = 0.76; 95% CI: 0.62 – 0.94) and being female (GM ratio = 0.87; 95% CI: 0.77 – 0.98) was associated with lower FeNO. Participants with FeNO ≥ 50 ppb were more likely to be atopic (OR = 3.19; 95% CI: 1.59 – 6.39) and have a history of hay fever (OR = 2.05; 95% CI: 1.08 – 3.93).

Table 6.6: Host risk factors associated with bronchial hyperresponsiveness and FeNO among health workers in the tertiary hospitals

	Prevalence: n (%)	**Dose-response slope (DRS)**‡ (n = 239)	**NSBH** (n = 446)	**FeNO, ppb**‡ (n = 654)	**FeNO≥ 50 ppb** (n = 654)
Prevalence: n (%)			57 (13)		41 (6)
Demographic characteristics					
Age		1.00 (0.98 – 1.03)	1.02 (0.99 – 1.05)	1.00 (1.00 – 1.01)	0.99 (0.96 – 1.02)
Gender (Females vs Males)		**3.40 (1.72 – 6.73)*****	2.08 (0.91 – 4.75)	**0.87 (0.77 – 0.98)***	0.84 (0.40 – 1.76)
BMI		0.98 (0.96 – 1.01)	1.00 (0.97 – 1.03)	1.00 (1.00 – 1.01)	1.01 (0.98– 1.04)
Smoking history					
Smoking (ever) ‡‡	90 (13)	0.88 (0.48 - 1.61)	1.07 (0.50 – 2.29)	0.88 (0.76 – 1.02)	0.16 (0.02 – 1.16)
Current smoking	42 (6)	1.02 (0.46 - 2.26)	0.98 (0.33 – 2.92)	**0.76 (0.62 – 0.94)****	0.34 (0.05 – 2.52)
Allergy history					
Family history of allergy	353 (51)	1.25 (0.72 – 2.18)	1.01 (0.58 - 1.77)	1.04 (0.94 - 1.15)	1.21 (0.64 – 2.29)
Atopy (positive Phadiatop)	296 (43)	**1.83 (1.08 – 3.10)***	1.22 (0.70– 2.12)	**1.38 (1.25 – 1.52)*****	**3.19 (1.59 – 6.39)****
Medical history					
Hay fever	306 (44)	**2.01 (1.19 – 3.39)****	1.16 (0.67 - 2.03)	**1.16 (1.05 – 1.28)****	**2.05 (1.08 – 3.93)***
Childhood-onset (≤16 yrs) asthma	19 (3)	**9.01 (1.59 – 50.93)***	1.74 (0.48 – 6.37)	**1.49 (1.11 - 1.99)****	2.94 (0.82– 10.52)
Adult-onset (>16 yrs) asthma	29 (4)	2.91 (0.88 – 9.61)	0.71 (0.16 - 3.12)	1.22 (0.95 - 1.57)	1.93 (0.56 – 6.70)
Repeated childhood chest infections	76 (11)	1.31 (0.49 – 3.49)	0.56 (0.19 – 1.62)	1.03 (0.87 – 1.20)	1.17 (0.44 – 3.08)
Chronic bronchitis	44 (6)	**2.61 (1.20 – 5.67)***	**2.41 (1.07 – 5.42)***	1.19 (0.98 – 1.46)	1.13 (0.33 – 3.81)
Pulmonary tuberculosis	32 (5)	0.46 (0.14 – 1.44)	0.35 (0.05 – 2.64)	1.10 (0.87 – 1.39)	1.03 (0.24– 4.47)
Domestic chemical exposures					
Home cleaning in the past 12 months (≥1 day vs < 1 day/week)	601 (86)	3.12 (0.84 – 11.62)	1.83 (0.63 – 5.28)	0.95 (0.82 – 1.09)	1.16 (0.44 – 3.05)
Use of sprays for home cleaning in the past 12 months (≥1 day vs <1 day/week)	218 (31)	1.28 (0.74 – 2.21)	1.71 (0.98 – 2.99)	**1.13 (1.01 – 1.25)***	1.09 (0.56 – 2.12)

Data presented as OR (95% CI), unless otherwise indicated; OR: odds ratio; CI: confidence interval; ‡: Geometric mean ratio (95% CI); *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001; ‡‡: current & ex-smokers vs never smokers; NSBH: nonspecific bronchial hyperresponsiveness; NSBH defined as any of the following two criteria: PD_{20} methacholine < 0.4 mg OR positive BDR: ≥12% and ≥ 200 ml increase in FEV_1 after administration of a bronchodilator; Each OR represents a separate unadjusted regression model

6.3.6. Host risk factors associated with asthma phenotypes

Participants with current asthma were more likely to be atopic (OR = 2.04; 95% CI: 1.23 – 3.39), with family history of allergy (OR = 2.25; 95% CI: 1.32 – 3.82), history of hay fever (OR = 2.30; 95% CI: 1.38 – 3.83), repeated childhood chest infections (OR = 2.08; 95% CI: 1.08 – 4.02), chronic bronchitis (OR = 3.42; 95% CI: 1.64 – 7.12) and PTB (OR = 3.95; 95% CI: 1.75 – 8.91) (Table 6.7). Atopic asthma was positively associated with family history of allergy (OR = 2.48; 95% CI: 1.24 – 4.94), history of hay fever (OR = 2.93; 95% CI: 1.49 – 5.76), repeated childhood chest infections (OR = 2.47; 95% CI: 1.13 – 5.40), chronic bronchitis (OR = 3.44; 95% CI: 1.43 – 8.29) and skin symptoms (OR = 2.25; 95% CI: 1.19 – 4.25). Participants with non-atopic asthma were more likely to be smoking (OR = 3.77; 95% CI: 1.35 – 10.57) and have had PTB (OR = 6.75; 95% CI: 2.52 – 18.05). Work-related asthma was positively associated with atopy (OR = 3.20; 95% CI: 1.12 – 9.19), history of hay fever (OR = 3.15; 95% CI: 1.10 – 9.04) and PTB (OR = 10.08; 95% CI: 3.31 – 30.64).

Table 6.7: Host risk factors associated with asthma phenotypes among health workers in the tertiary hospitals

	Prevalence: n (%)	Current asthma	Atopic Asthma	Non-atopic Asthma	Work-related Asthma
Prevalence: n (%) (n = 697)		69 (10)	41 (6)	28 (4)	17 (2)
Demographic characteristics					
Age		**1.03 (1.01 – 1.06)***	1.02 (0.99 – 1.05)	**1.04 (1.00 - 1.08)***	1.01 (0.97– 1.06)
Gender (females vs males)		1.72 (0.86 – 3.46)	2.68 (0.94 – 7.65)	1.02 (0.41– 2.56)	NC
BMI		1.02 (1.00 – 1.05)	1.03 (1.00– 1.06)	1.01 (0.96 – 1.05)	1.03 (0.99 – 1.06)
Smoking history					
Smoking (ever) ‡‡	90 (13)	1.32 (0.66 – 2.62)	0.72 (0.25– 2.06)	2.35 (0.97 – 5.71)	0.42 (0.05 – 3.17)
Current smoking	42 (6)	1.89 (0.81 – 4.45)	0.77 (0.18– 3.31)	**3.77 (1.35 – 10.57)***	0.90 (0.12– 6.96)
Allergy history					
Family history of allergy	353 (51)	**2.25 (1.32 – 3.82)****	**2.48 (1.24 – 4.94)***	1.80 (0.82– 3.95)	1.40 (0.53– 3.73)
Atopy (positive Phadiatop)	296 (43)	**2.04 (1.23 – 3.39)****	NA	NA	**3.20 (1.12 – 9.19)***
Medical history					
Hay fever	306 (44)	**2.30 (1.38 – 3.83)****	**2.93 (1.49 – 5.76)****	1.50 (0.70 – 3.20)	**3.15 (1.10 – 9.04)***
Childhood-onset (≤16 yrs) asthma	19 (3)	**31.72 (11.01 – 91.33)*****	**29.70 (11.13 – 79.26)*****	**4.90 (1.34 – 17.90)***	**8.89 (2.32 – 34.03)****
Adult-onset (>16 yrs) asthma	29 (4)	**51.83 (20.11 – 133.63)*****	**15.55 (6.80 – 35.58)*****	**23.40 (9.60 – 57.06)*****	**37.13 (12.98 – 106.21)*****
Repeated childhood chest infections	76 (11)	**2.08 (1.08 – 4.02)***	**2.47 (1.13 – 5.40)***	1.38 (0.47– 4.10)	1.78 (0.50 - 6.35)
Chronic bronchitis	44 (6)	**3.42 (1.64 – 7.12)****	**3.44 (1.43 – 8.29)****	2.62 (0.87– 7.92)	2.03 (0.45– 9.15)
Pulmonary tuberculosis	32 (5)	**3.95 (1.75 – 8.91)****	1.71 (0.50– 5.86)	**6.75 (2.52 – 18.05)*****	**10.08 (3.31 – 30.64)*****
Skin symptoms					
Skin symptoms (ever)	215 (31)	1.51 (0.90 – 2.51)	**2.25 (1.19 – 4.25)***	0.74 (0.31– 1.77)	0.93 (0.32 – 2.68)
Two or more episodes of skin symptoms in the last 12 months	125 (18)	1.31 (0.71 – 2.40)	1.52 (0.72 – 3.18)	1.00 (0.37 – 2.67)	1.42 (0.46– 4.44)
Symptoms affecting hands or forearms#	86 (12)	1.40 (0.70 – 2.78)	1.50 (0.65– 3.51)	1.19 (0.40 – 3.53)	1.54 (0.43 – 5.48)
Symptoms affecting the whole body#	36 (5)	0.82 (0.25– 2.75)	1.49 (0.44– 5.08)	NC	2.53 (0.56 – 11.53)
Work-related skin symptoms (ever)	130 (19)	1.49 (0.83 – 2.67)	1.89 (0.94– 3.81)	0.95 (0.35 – 2.54)	0.93 (0.26 – 3.30)
Work-related skin symptoms in the past 12 months	80 (12)	1.18 (0.56– 2.47)	1.35 (0.55– 3.31)	0.92 (0.27 – 3.13)	0.48 (0.06 – 3.63)
Doctor-diagnosed work-related skin symptoms (ever)	20 (3)	1.63 (0.47– 5.72)	2.97 (0.83 – 10.57)	NC	2.17 (0.27 – 17.25)
Domestic chemical exposures					
Home cleaning in the past 12 months (≥1 day vs <1 day/week)	601 (86)	0.94 (0.46 – 1.90)	1.51 (0.53– 4.33)	0.57 (0.23– 1.44)	1.20 (0.27 - 5.35)
Use of sprays for home cleaning in the past 12 months (≥1 day vs <1 day/week)	218 (31)	1.11 (0.66 – 1.88)	1.44 (0.75 – 2.75)	0.72 (0.30 – 1.73)	0.91 (0.32 – 2.63)

Data presented as OR (95% CI); OR: odds ratio; CI: confidence interval; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001; ‡‡: current & ex-smokers vs never smokers; #: presence of itchy/scratchy skin, hives, dry/scaly skin, redness of the skin, blisters/weeping skin or burning skin; NC: not calculable; NA: not applicable; Each OR represents a separate unadjusted logistic regression model

6.4. DISCUSSION

In this study of health workers employed in two tertiary academic hospitals in sub-Saharan Africa, the prevalence of atopic asthma was found to be more prevalent than non-atopic asthma. Furthermore, most asthma-related outcomes and work-related symptoms were positively associated with host attributes of allergic disease further suggesting a more dominant role of allergic mechanisms in asthma and work-related symptoms experienced by these HWs. The weak, but positive association between NSBH and FeNO suggests that these two outcomes detect different underlying pathophysiological mechanisms that produce different asthma phenotypes. The stronger associations were also observed for asthma symptoms when FeNO ≥ 50 ppb (a marker of allergic airway inflammation) was combined with NSBH (BDR or MCT positive). Furthermore, atopic individuals were also more likely to be sensitised to LMW agents such as OPA and chlorhexidine, an association commonly observed with HMW agents.

The prevalence of current asthma (10%) observed in this study was similar to the Spanish study (11%) of professional cleaners (including hospital cleaners) (24) but higher than that reported among nurses (6%) in a general population study of 13 European countries (8). The definition of current asthma used in the current study was similar to the two European studies (8,24). The reported prevalence of asthma among HWs has varied as has been reported for other occupational groups probably due to the different asthma definitions used in these studies (29). However, in this current study, the prevalence of atopic asthma (6%) was similar to that reported in South African dental HWs (6.9%) (30). On the other hand, the prevalence of non-atopic asthma in this current study (4%) was slightly lower than that reported in the South African dental HWs (5.9%). (30). Furthermore, the prevalence of work-related asthma (2%) in this study was on the lower end of the spectrum of prevalence (3 – 13%) reported from recent workplace based studies in South Africa (12,31,32).

It is interesting to note that, in this study, atopic asthma (6%) was more prevalent than non-atopic asthma (4%). In addition, most asthma-related outcomes (DRS, asthma symptom score and current asthma) and work-related outcomes (WRONS, WRAS and work-related asthma) were positively associated with allergic disease attributes (atopy, history of hay fever, family history of allergy and FeNO). In this study, there was also a weak positive association between bronchial hyperresponsiveness (MCT+BDR) and FeNO. Similar findings have been observed in corticosteroid-naive patients with normal FEV_1 on baseline spirometry (33). These findings suggest different underlying pathophysiological mechanisms that co-exist. However, it would appear that allergic mechanisms may be playing a more dominant role in work-related asthma in these HWs. The pathophysiological mechanisms involved in asthma related to cleaning agents are still not yet clear for most of the cleaning chemicals. Previous studies have suggested involvement of both allergic and irritant mechanisms although the latter has been generally thought to be the dominant mechanism (6,34). Furthermore, it is probable that both these mechanisms may enhance each other, such that airway epithelial damage due to irritant exposures can also activate an allergic T helper type 2 (Th2) response and increase the risk of sensitisation (6,34).

In this current study, stronger associations were observed for asthma symptoms when FeNO ≥ 50 ppb (a marker of allergic airway inflammation) was combined with NSBH (BDR or MCT positive). Furthermore, stronger associations were also observed between sensitisation to occupational allergens and atopy. With exception of one non-atopic participant who was sensitised to OPA, all the remaining participants who were sensitised to occupational allergens (OPA, chlorhexidine and NRL) were atopic (data not shown). While several studies have observed a higher likelihood of atopic individuals developing sensitisation to high molecular weight occupational allergens such as natural rubber latex (30–32,35), this association has not been observed with low molecular weight occupational allergens such as OPA and chlorhexidine, although, serum specific IgE antibodies to OPA and chlorhexidine have been detected in a few studies of individuals exposed to these agents (36–39). Furthermore, animal studies have suggested that OPA is a respiratory and dermal sensitiser as was evidenced by a predominant expression of Th2 cytokines (IL-4, IL-5 and IL-13) in mice that were exposed to OPA (40,41). In addition, the clinical history in the case reports of asthma due to OPA also demonstrated a latency period between first exposure to OPA and development of symptoms implying immunologic response caused by OPA (42,43). Interestingly, animal studies have also suggested that OPA is more irritant than GTA using both *in-vitro* EpiDerm Skin Irritation Test and *in-vivo* tests (40). In addition to being consistent with an immunological mechanism, this further suggests that the mechanism is probably IgE-mediated. Future studies should investigate this further so as to have a better understanding of the underlying pathophysiological mechanisms associated with asthma to these agents.

As to be expected, FeNO (a non-invasive marker of eosinophilic airway inflammation) was positively associated with allergic predictors (atopy and history of hay fever) and a history of childhood-onset asthma. Even stronger associations were observed with high FeNO (≥50 ppb) levels. A positive association between FeNO and atopy is well-known and has also been reported in recent South African studies in other occupational exposure contexts (30,44,32), while the few studies that have conducted FeNO studies in Tanzania did not assess the role of atopy (45,46). Furthermore, a strong positive association (OR_{unadj} = 3.59, CI: 1.63 – 7.93; OR_{adj} (atopy + smoking) = 1.93, CI: 0.85 – 4.37) was also observed between elevated FeNO (≥25 ppb) and allergic sensitisation to OPA / chlorhexidine (data not shown).

Much stronger relationships have been demonstrated in workplace-based studies among South African workers exposed to predominantly high molecular weight agents (30,44).

In this current study, a positive association was observed between female gender and asthma-related outcomes (asthma symptom score, WRAS and DRS). New-onset asthma in adulthood has been shown to be more prevalent amongst women with female sex hormones implicated in the pathogenesis (1). Furthermore, this could also be explained by the gendered distribution of the workforce, since a large proportion (78%) of study participants were women. This is consistent with other studies of asthma and occupational exposures to cleaning agents that have reported an increased risk amongst women as they are more likely to be exposed to cleaning agents than men (16,47,48).

Interestingly, in the current study, a past history of pulmonary tuberculosis (TB) was strongly associated with asthma symptoms, current asthma as well as work-related asthma. This association persisted even after adjusting for age, gender, smoking, atopy and body mass index. Similar findings have also been reported in South African population-based and workplace-based studies (49). In a recent study among adults exposed to a sulphur stockpile fire incident, a past history of TB (more than one year prior to the fire) was an important predictor for chronicity of asthma-related symptoms (50). Due to the cross-sectional nature of this current study, it was not possible to establish a temporal relationship between TB and asthma-related outcomes. However, since all of the asthma-related outcomes were based on recent symptoms (past 12 months), it is probable that the TB preceded the symptoms. This observation needs further exploration in a larger longitudinal study of these health workers.

In this study, smoking was positively associated with asthma symptom score (≥2 vs 0-1) as well as with non-atopic asthma. However, smoking was not associated with allergic sensitisation to occupational allergens, NSBH, current asthma, work-related ocular-nasal symptoms nor with work-related asthma. This is consistent with the current body of evidence of asthma on the association between smoking and occupational asthma (1,6,51). While some studies have demonstrated that smoking at baseline increased the risk of incident asthma in adulthood, no significant association was reported in a follow-up cross-sectional analysis (52). Overall, various studies have reported inconsistent findings of the association between smoking and asthma in general and with occupational asthma in particular (1,51). Furthermore, very limited specific information is available on the risk of smoking in relation to asthma among HWs exposed to cleaning agents (51,53). The study by Zock *et al*. in cleaning workers did not demonstrate any association between smoking and asthma (53). Additional longitudinal studies are needed to better understand this relationship between smoking, occupational allergic sensitisation and asthma risk among health workers exposed to cleaning agents.

Despite the major strengths of this study in using additional objective markers for asthma, there were some limitations of the methodology. Some of the asthma phenotypes such as current asthma, asthma symptom score and work-related asthma were based on self-reported information from the questionnaire. This could have resulted in misclassification of asthma status. Self-reported symptom information is usually characterised by high sensitivity but low specificity in identifying individuals with asthma. However, in this study, self-reported asthma information obtained from a standardised questionnaire correlated relatively well with NSBH and FeNO, suggesting that this did not impact significantly on the results obtained.

6.5. CONCLUSION

This study has demonstrated that atopic asthma was more prevalent than non-atopic asthma. Furthermore, most asthma-related outcomes and work-related symptoms were positively associated with allergic attributes suggesting a more dominant role of allergic mechanisms in asthma and work-related symptoms experienced by these HWs. The stronger associations observed for asthma symptoms when high FeNO (≥ 50 ppb) was combined with NSBH (BDR + MCT), together with the finding that atopic individuals were more likely to be sensitised to LMW occupational allergens such as OPA and chlorhexidine, further suggests an IgE mediated mechanism underlying the asthma reported in this group of HWs.

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Chapter 7

Environmental risk factors for asthma among health workers exposed to specific cleaning agents in two large tertiary hospitals in South Africa and Tanzania

ABSTRACT

Background: Previous studies have demonstrated an association between asthma-related outcomes and broad categories of cleaning-related exposures in health care settings. However, there is little information on the specific cleaning agents and tasks associated with various asthma-related outcomes. Furthermore, very limited information exists regarding exposure-response relationships between the frequency of exposure to specific cleaning agents and asthma-related outcomes. This study investigated the environmental risk factors and exposure response relationships for various asthma-related outcomes among HWs exposed to diverse cleaning agents in two academic tertiary hospitals in South Africa and Tanzania.

Methods: A cross-sectional study of 699 HWs was conducted in two large tertiary hospitals. A total of 697 participants completed questionnaire interviews, which contained information on asthma, based on the ECRHS study, as well as detailed information on tasks and chemicals used during the course of their work. Sera was collected from 682 HWs and analysed for specific immunoglobulin E (sIgE) antibody reactivity to common aero-allergens (Phadiatop) and specific occupational allergens (NRL - *Hevea brasiliensis* (Hev b5, Hev b6.02), chlorhexidine and OPA). Methacholine challenge tests (MCT) were performed on all South African HWs (n=318), based on standard inclusion criteria. Spirometry, accompanied by a post-bronchodilator (post-BD) test was conducted on all Tanzanian HWs (n=329) and a small proportion (n=25) of South African HWs (SAHWs) where MCT was contraindicated. All HWs from both hospitals (n=654) underwent fractional exhaled nitric oxide (FeNO) testing during the working day prior to spirometry. An asthma symptom score was computed based on the sum of answers to five questions on asthma-related symptoms in the past 12 months. Nonspecific bronchial hyperresponsiveness (NSBH) was defined as either positive MCT (PD_{20} methacholine < 0.4 mg) or presence of a significant bronchodilator response - BDR (≥12% and ≥ 200 ml increase in FEV_1 after administration of a bronchodilator). A continuous index of NSBH (dose-response slope - DRS) was calculated from MCT results. For exposure-response analyses, cleaning-related predictor variables were categorised into 3 levels (cleaning product not used; use of a cleaning product for up to 99 minutes per week and use of a cleaning product for ≥ 100 minutes per week).

Results: Asthma-related outcomes (increasing asthma symptom score and FeNO) demonstrated consistent positive associations with certain medical instrument cleaning agents (OPA, QACs and enzymatic cleaners) and tasks (pre-cleaning of medical instruments, changing sterilisation solutions and manual disinfection of medical instruments) as well as certain patient care activities (disinfection prior to procedures, cleaning/disinfecting wounds, application of wound dressing, usage of adhesives and

adhesive removing solvents). A particularly pronounced dose-response relationship was observed between work-related ocular-nasal symptoms and medical instrument cleaning agents (OPA, glutaraldehdye, QACs, enzymatic cleaners, alcohols and bleach; OR range: 2.50 – 12.08) and tasks (OR range: 2.58 – 3.97). Furthermore, a strong association was observed between higher asthma symptom scores and use of more sprays than wipes for fixed surface cleaning activities (mean ratio = 3.00; 95% CI: 1.50 – 5.98).

Conclusion: Specific cleaning agents such as OPA, quaternary ammonium compounds and enzymatic cleaners associated with medical instrument cleaning/disinfection as well as patient care activities and the use of sprays for fixed surface cleaning are important environmental risk factors, for various asthma-related outcomes among health workers in health care settings.

7.1. INTRODUCTION

Previous studies have demonstrated an association between asthma or respiratory symptoms and broad categories of cleaning-related exposures in health care settings involved with medical instrument cleaning and disinfection, fixed surfaces cleaning and disinfection, floor finishing tasks (stripping, waxing and buffing), patients' skin/wound cleaning and disinfection and hand washing/sanitising activities (1–4). However, only a few epidemiological studies and case reports have identified the specific cleaning agents related to asthma and other health outcomes (5–7).

Products used for medical instrument cleaning and disinfection such as glutaraldehyde, ortho-phthalaldehyde (OPA) and quaternary ammonium compounds (QACs) have been implicated in the causation and exacerbation of work-related asthma and upper airway outcomes such as rhinitis (7–10). Little is known regarding exposure-response relationships between exposure to specific cleaning agents and asthma-related outcomes. A few studies have only reported exposure-response relationships for broad categories of cleaning-related exposures with very limited information on specific cleaning agents (e.g. OPA) used for medical instrument cleaning and disinfection (6). Arif *et al*. demonstrated exposure-response relationships for work-exacerbated asthma in HWs who used disinfectants for medical instrument disinfection (6). In recent years, there has been an increase in the use of enzymatic cleaners for pre-cleaning of medical instruments prior to high-level disinfection in various health care settings (11,12). Two studies have reported cases of occupational asthma and rhinitis among HWs using enzymatic cleaners (12,13). Hydrogen peroxide and a mixture of hydrogen peroxide, peracetic acid and acetic used for high-level disinfection of medical instruments have also been linked to respiratory and ocular symptoms (14,15).

Several studies have reported an association between asthma and fixed surface cleaning products such as ammonia and bleach (5–7,10,16–18). A Spanish study among cleaning workers employed in various settings including hospitals, reported an increased risk of asthma symptoms in workers using hydrochloric acid (mean ratio [MR] = 1.7; 95% CI: 1.1 to 2.6), degreasers (MR = 1.6; 95% CI: 1.0 to 2.4), air fresheners (MR = 1.5; 95% CI: 1.0 to 2.4) or ammonia (MR = 1.6; 95% CI: 1.0 to 2.5) in the last year (16). Recently, Dumas *et al.* (7) demonstrated an association between poor asthma control and exposure to hypochlorite bleach among US nurses. A previous US study demonstrated exposure-response relationships between use of cleaning agents for fixed surfaces cleaning/disinfection and work-related asthma symptoms (6). Medina-Ramon *et al*. demonstrated dose-response relationship between use of bleach and asthma among domestic cleaners in Spain (19). Similarly, Zock *et al*. demonstrated dose-response relationships for asthma with the frequency of use of cleaning sprays as well as with increasing number of the types of sprays used (20).

In order to adhere to strict infection prevention standards in health care settings, HWs wash and sanitise their hands quite frequently, using products such as alcohols, chlorhexidine and povidone iodine (21–23). Alcohols, chlorhexidine and povidone iodine are the most commonly reported agents used for hand hygiene (21–23). Chlorhexidine is well known for its sensitising and irritating properties to both the skin and airways (21–23). Previous studies have reported cases of occupational asthma and dermatitis due to chlorhexidine (21–23). Alcohols are potential respiratory and skin irritants. Povidone iodine is a well-known skin irritant but its sensitising properties have not been well characterised (24). There is little information from epidemiological studies regarding the potential respiratory risks associated with hand hygiene practices among HWs, with very limited focus on exposure-response relationships (23). In a recent study by Dumas *et al*., poor asthma control was positively associated with increased frequency of hand hygiene practices among US nurses, with clear dose-response relationship demonstrated for surgical hand/arm hygiene (23).

Patient care activities performed by nurses often includes the use of adhesives and adhesive removers, particularly in surgical and intensive care units (8,11). A US study (8) found an almost 2-fold increased odds of asthma among nursing professionals who were exposed to adhesives, adhesive removers and / or solvents. Alcohols, chlorhexidine and povidone iodine are also commonly used in hospital settings for disinfection of wounds and patients' skin before various medical procedures (24).

There is little information on the specific cleaning agents and tasks associated with various asthma-related outcomes. Furthermore, very limited information exists regarding exposure-response relationships between the frequency of exposure to specific cleaning agents (e.g. OPA) and asthma-related outcomes. This specific information is needed to guide the development of appropriate preventive strategies in health care settings. The aim of this study was to determine the association between exposure to specific cleaning agents (e.g. OPA, glutaraldehyde and enzymatic cleaners), associated tasks and duration of use, and their relationship with various asthma-related outcomes in health workers. .

7.2. METHODS

7.2.1. Study design, Population and Sampling

A cross-sectional study of **699** HWs was conducted in two large tertiary academic hospitals (**346** from a South Africa hospital – SAH and **353** from Tanzanian hospital - TAH). All permanently employed HWs in the high-risk departments, as previously described (Chapter 3), constituted the sampling frame of the study. Doctors were excluded from the sampling frame as they were more likely to work in multiple different exposure settings across the hospital. A list of all permanently employed HWs in the high-risk departments of both hospitals was obtained from their respective managers. Study participants were selected from these departments through stratified random sampling according to job title, choosing up to five HWs from each high-risk department. For departments having more than five HWs with the same job title, a random sample of five workers was selected. For departments having less than five workers, all workers were selected to participate in the study. Ethics approval was obtained from the Human Research Ethics Committee (HREC) of the University of Cape Town (HREC Ref: 212/2013), Muhimbili University of Health and Allied Sciences (MUHAS) Institutional Review Board and University of Michigan Medical School Institutional Review Board (HUM00083115).

7.2.2. Questionnaire

A total of **697** participants completed the questionnaire interviews (**344** from SAH and **353** from TAH). Each participant answered a modified questionnaire for the investigation of asthma as contained in the Protocol for the European Community Respiratory Health Survey (25). The study questionnaire also included validated questions from the NIOSH specific questionnaire for cleaning agents in the health care setting (26). The questionnaire was administered by trained interviewers in English language for South African health workers (SAHWs) and in Swahili language for Tanzanian health workers (TAHWs). The translated Swahili questionnaire was back-translated to ensure validity and repeatability.

7.2.3. Immunological assessment

Blood samples were collected from **682** participants (**339** SAHWs and **343** TAHWs). Specific IgE antibody reactivity to common aero-allergens (Phadiatop) and specific occupational allergens was evaluated. The quantification of specific IgE antibodies to specific occupational allergens: NRL (*Hevea brasiliensis* - Hev b5, Hev b6.02), chlorhexidine and OPA was performed using the UniCAP system (Phadia, Uppsala, Sweden). Immunological assessment for chlorhexidine was only done on sera of SAHWs since chlorhexidine containing chemicals were not used in the TAH.

Commercial ImmunoCAPs containing Phadiatop (Phad), Chlorhexidine (C8), rHev b5 (K218) and rHev b6.02 (K220) allergens were obtained from Thermo Scientific. Since the OPA test was not readily available commercially, it required further development as previously described (Chapter 3). Serum samples were tested at the National Institute for Occupational

Health (NIOH) Immunology laboratory using the UNICAP 250 machine supplied by Thermo Scientific according to the manufacturer's manual.

7.2.4. Spirometry (pre and post-bronchodilator)

There were **328** participants from the TAH and **25** participants from the SAH who performed spirometry (pre- and post-bronchodilator). The latter group did not proceed to methacholine challenge testing (see below) due to contra-indications (e.g. FEV_1 below 1.5 litres or 70% predicted, pregnant and breastfeeding women). Spirometry was conducted according to guidelines of the American Thoracic Society/European Respiratory Society (ATS/ERS) (27) using EasyOne World spirometer (ndd Medical Technologies, Zurich, Switzerland) at the TAH and Jaeger Aerosol Provocation System (APS) Pro apparatus at the SAH according to the manufacturer's instructions as previously described.

7.2.5. Methacholine challenge tests

Methacholine challenge testing (MCT) was only performed in the South African study site due to logistical considerations. The tests were conducted in a pulmonary function laboratory that was well equipped with appropriate resuscitation facilities. Among **318** participants who underwent spirometry, **239** performed interpretable PD_{20} methacholine results while **52** participants had ≥10% decrease in FEV_1 after administration of saline diluent and were therefore not considered for MCT. MCT was discontinued in **two** participants who requested the test to be stopped. As explained above, **25** participants underwent post-bronchodilator spirometry, since MCT was contraindicated. MCT was conducted under the supervision of an experienced technologist according to an abbreviated protocol used in epidemiological surveys. The Medic Aid Pro Nebulizer dosimeter method involved a protocol of increasing numbers of breaths to achieve pre-defined cumulative doses of methacholine (28). The doses were delivered by the Jaeger APS MedicAid Side Stream APS-Nebulizer according to the manufacturer's instructions, commencing with the lowest dose of 0.026 mg. The dose was increased to a maximum of 2.048 mg methacholine if a positive endpoint (fall in FEV_1 of 20% or more) was not obtained. The results of the MCT were interpreted as follows: borderline defined as 0.4mg $<PD_{20}M<$1.0 mg; mild = 0.08 mg $< PD_{20}M <$0.4mg; moderate/severe = $PD_{20}M<$ 0.08mg. Borderline values for $PD_{20}M$ were considered negative in the definition of non-specific bronchial hyper responsiveness (NSBH) as previously described.

7.2.6. Fractional exhaled nitric oxide (FeNO)

A total of **654** participants performed FeNO tests (**334** from SAH and **320** from TAH). A hand-held portable exhaled nitric oxide sampling device (NIOX MINO® Airway Inflammation Monitor (NIOX MINO); Aerocrine AB, Solna, Sweden) was used according to the manufacturer's instructions. Two technically adequate measurements were performed in line with the current American Thoracic Society /European Respiratory Society recommendations (29). A third maneuver was performed if the difference between the first two measurements was more than 10 ppb. The FeNO test was done during the work shift before spirometry / MCT.

7.2.7. Operational definitions of asthma-related outcomes and environmental risk factors

Information on which the asthma phenotypes were based was obtained from the modified ECRHS questionnaire, immunological tests, spirometry (pre- and post-bronchodilator), methacholine challenge tests and FeNO levels.

An asthma symptom score was computed based on the sum of answers (0=no, 1=yes) to five questions reported in the past 12 months. These included the presence of shortness of breath while wheezing; being woken up with chest tightness; an attack of shortness of breath at rest; an attack of shortness of breath after exercise; and being woken up by an attack of shortness of breath, as has been described in previous studies (30,31,16,32). A binary variable was created from these five asthma-related symptoms (≥ 2 symptoms vs 0-1 symptom). Having ≥ 2 asthma-related symptoms was considered 'more symptomatic' and 0-1 symptom as 'less symptomatic'.

A categorical variable for NSBH was defined as any of the following two criteria: positive methacholine challenge test (PD_{20} methacholine < 0.4 mg) or significant bronchodilator response (≥12% and ≥ 200 ml increase in FEV_1 after administration of a bronchodilator).

Two continuous indices of MCT (continuous index of responsiveness (CIR) and dose-response slope (DRS)) were also calculated (33). CIR = (Post-diluent FEV_1 – FEV_1 at the last dose of methacholine) ÷ Post-diluent FEV_1 and DRS = (Post-diluent FEV_1 – FEV_1 at the last dose of methacholine) ÷ (Post-diluent FEV_1 x Last methacholine dose) (33). CIR and DRS were all multiplied by 100 to convert them into percentages.

FeNO results were interpreted as follows: low < 25ppb; elevated for values 25 - 50ppb; and high for values > 50ppb, the last mentioned is generally considered to signify the presence of allergic airway inflammation (34). In addition to FeNO being analysed as a continuous variable, two categorical variables (FeNO ≥ 25 ppb and FeNO ≥ 50 ppb) were also computed to gain more specificity in the analysis. Individuals with atopy were defined as those subjects having a positive Phadiatop test.

Further information on the environmental risk factors was based on information obtained from the questionnaire, which had detailed information on use of cleaning agents and related tasks in the past 12 months. This included information on the duration of use per day for each cleaning agent and number of days used per week (26). For cleaning tasks, the questionnaire included information on the typical duration of each individual task, number of times per day that the task was performed and the number of days per week an individual HW performed the task in question (26). Furthermore, for each cleaning agent, frequency of use per week was calculated by multiplying duration of use per day and number of days used per week. Similarly, for each cleaning task, frequency of task performance per week was calculated by multiplying duration of the task, number of times the task was performed per day and number of days the task was performed per week. For exposure-response analyses, cleaning-related predictor variables were categorised into 3 levels (cleaning product not used; use of a cleaning product for up to 99 minutes per week and use of a cleaning product for ≥ 100 minutes per week). These cut-off numbers were chosen after studying the distribution of the data based on duration and frequency of exposure. These cut-offs were considered the best fit and appropriate to use across all cleaning agents used and tasks performed.

7.2.8. Statistical analysis

All data analyses were performed using statistical software STATA version 14 (StataCorp, College Station, Texas, USA). Univariate and bivariate analyses were conducted. Multivariate logistic and linear saturated regression models adjusted for atopy, gender and smoking were used to evaluate the association between asthma-related outcomes (and other relevant clinical endpoints) and cleaning-related risk factors (specific cleaning agents and tasks). The three covariates (atopy, gender and smoking) were selected *a priori* but they also had consistent associations with asthma-related outcomes. Age was also initially selected *a priori* although no consistent associations were observed with asthma-related outcomes. Furthermore, since effect estimates did not change significantly when age was added into the regression models it was therefore not included in the final models. For linear regression analyses, log transformed values of DRS and FeNO were used, with geometric mean ratios and 95% confidence intervals. A negative binomial regression analysis was used for the association between asthma symptom score (a count outcome variable) and cleaning-related risk factors. The results of the negative binomial regression models were reported as mean ratios with 95% confidence intervals.

7.3. RESULTS

7.3.1. Asthma-related outcomes associated with medical instrument cleaning and disinfection

Presence of work-related ocular-nasal symptoms (WRONS) in the past 12 months was positively associated with increased duration (≥100 minutes/week) of use of OPA (OR = 3.22; 95% CI: 1.43 – 7.25), glutaraldehyde (OR = 4.47; 95% CI: 1.61 – 12.45), enzymatic cleaners (OR = 2.59; 95% CI: 1.29 – 5.20), quaternary ammonium compounds (QACs) (OR = 12.08; 95% CI: 1.05 – 138.76), alcohols (OR = 4.40; 95% CI: 1.58 – 12.26) and bleach (OR = 2.50; 95% CI: 1.41 – 4.43) (**Table 7.1.1**). Furthermore, increased duration (≥100 minutes/week) of tasks such as manual disinfection of instruments (OR = 2.58; 95% CI: 1.20 – 5.55) and changing sterilisation solutions (OR = 3.97; 95% CI: 1.55 – 10.15) were also significantly associated with WRONS. An increased odds of work-related asthma symptoms (WRAS) in the past 12 months was also observed with hydrogen peroxide (OR = 3.14; 95% CI: 1.29 – 7.66) use for medical instrument disinfection. Furthermore, increasing asthma symptom score was also associated with pre-cleaning of instruments to remove gross contaminants (mean ratio = 1.41; 95% CI: 1.04 – 1.92), changing sterilisation solutions (mean ratio = 1.40; 95% CI: 1.00 – 1.94) and manual disinfection of medical instruments using immersion containers (mean ratio = 1.45; 95% CI: 1.03 – 2.03) **(Table 7.1.2)**.

While no significant associations were observed with markers of bronchial hyperresponsiveness, increasing FeNO levels were weakly associated with OPA (Geometric mean (GM) ratio = 1.19; 95% CI: 1.01 – 1.40) and chlorhexidine (GM ratio = 1.38; 95% CI: 1.14 – 1.66) use (**Table 7.2.1**). However, stronger associations were observed for FeNO ≥ 50 ppb among HWs who used QACs (OR = 5.31; 95% CI: 1.32 – 21.28), enzymatic cleaners (OR = 3.90; 95% CI: 1.53 – 9.98), OPA (OR = 3.73; 95% CI: 1.60 – 8.73) and chlorhexidine (OR = 2.91; 95% CI: 1.02 – 8.35) between 1-99 minutes per week. Furthermore, increasing FeNO was also associated with HWs that were involved with pre-cleaning of medical instruments to remove gross contaminants (GM ratio = 1.18; 95% CI: 1.05 – 1.34) and manually disinfected medical instruments (GM ratio = 1.16; 95% CI: 1.01 – 1.32) between 1-99 minutes per week (**Table 7.2.2**).

Table 7.1.1: Respiratory symptoms associated with specific chemicals in medical instrument cleaning and disinfection among health workers in the tertiary hospitals

	Prevalence (%)	Asthma symptom score##	Asthma symptom score (≥2 vs 0-1)	WRONS	WRAS
Prevalence (%) (n = 697)			91 (13)	109 (16)	48 (7)
Medical instruments cleaning and disinfection	301 (43)	1.14 (0.85 – 1.52)	1.06 (0.67 – 1.68)	1.26 (0.83 – 1.92)	0.75 (0.41 – 1.40)
Agents					
Ortho-phthalaldehyde					
Yes vs No	113 (16)	1.09 (0.75 – 1.60)	0.84 (0.45 – 1.58)	1.55 (0.92 – 2.60)	0.73 (0.30 – 1.77)
0 minutes / week	584 (86)	1	1	1	1
1 – 99 minutes / week	64 (10)	1.28 (0.80 – 2.05)	1.10 (0.52 – 2.32)	1.05 (0.51 – 2.16)	0.62 (0.18 – 2.07)
≥ 100 minutes / week	30 (4)	1.15 (0.58 – 2.26)	0.72 (0.21 – 2.47)	**3.22 (1.43 – 7.25)****	1.47 (0.42 – 5.16)
Glutaraldehyde					
Yes vs No	49 (7)	1.03 (0.59 – 1.81)	1.17 (0.50 – 2.75)	1.42 (0.68 – 2.96)	1.14 (0.39 – 3.37)
0 minutes / week	648 (94)	1	1	1	1
1 – 99 minutes / week	28 (4)	1.14 (0.56 – 2.30)	1.18 (0.39 – 3.57)	0.66 (0.20– 2.24)	1.00 (0.23 – 4.40)
≥ 100 minutes / week	16 (2)	0.79 (0.27 – 2.34)	1.07 (0.23 – 4.93)	**4.47 (1.61 – 12.45)****	2.02 (0.43 – 9.47)
Enzymatic cleaners					
Yes vs No	113 (16)	1.16 (0.80– 1.70)	1.17 (0.65 – 2.10)	1.20 (0.70– 2.06)	1.39 (0.66 – 2.91)
0 minutes / week	584 (87)	1	1	1	1
1 – 99 minutes / week	46 (7)	1.52 (0.89 – 2.59)	1.72 (0.78 – 3.80)	0.66 (0.25– 1.74)	1.64 (0.60 – 4.47)
≥ 100 minutes / week	43 (6)	1.15 (0.64 – 2.09)	0.95 (0.36 – 2.54)	**2.59 (1.29 – 5.20)****	1.18 (0.34 – 4.05)
Chlorhexidine					
Yes vs No	84 (12)	1.26 (0.83 – 1.92)	0.85 (0.43 – 1.71)	0.66 (0.33 – 1.34)	0.61 (0.21 – 1.76)
0 minutes / week	613 (91)	1	1	1	1
1 – 99 minutes / week	44 (7)	1.41 (0.81 – 2.45)	0.64 (0.22 – 1.87)	0.64 (0.25 – 1.69)	NC
≥ 100 minutes / week	13 (2)	1.54 (0.60 – 3.95)	0.94 (0.20 – 4.41)	1.52 (0.41 – 5.71)	0.96 (0.12 – 7.78)

Data are presented as OR (95% CI), unless otherwise indicated. ##: mean ratio (95% CI); OR: odds ratio; CI: confidence interval; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001;
Each OR represents a separate model adjusted for atopy, gender and smoking; WRONS: Work-related ocular–nasal symptoms (ocular–nasal symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; WRAS: Work-related asthma symptoms (asthma symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; NC: not calculable

Table 7.1.1 (contd.): Respiratory symptoms associated with specific chemicals in medical instrument cleaning and disinfection among health workers in the tertiary hospitals

	Prevalence (%)	Asthma symptom score[##]	Asthma symptom score (≥2 vs 0-1)	WRONS	WRAS
Prevalence (%) (n = 697)			91 (13)	109 (16)	48 (7)
Medical instruments cleaning and disinfection	301 (43)				
Agents					
Quaternary ammonium compounds					
Yes vs No	26 (4)	1.02 (0.49 – 2.13)	1.41 (0.49 – 4.02)	0.91 (0.30 – 2.74)	2.09 (0.59 – 7.44)
0 minutes / week	671 (97)	1	1	1	1
1 – 99 minutes / week	15 (2)	0.84 (0.29 – 2.42)	0.99 (0.21 – 4.75)	0.34 (0.04 – 2.69)	NC
≥ 100 minutes / week	3 (1)	1.83 (0.29 – 11.57)	2.94 (0.25 – 34.30)	**12.08 (1.05 – 138.76)***	8.34 (0.62 – 111.58)
Hydrogen peroxide					
Yes vs No	40 (6)	1.44 (0.81 – 2.56)	1.48 (0.62 – 3.53)	1.66 (0.76– 3.61)	**3.14 (1.29 – 7.66)***
0 minutes / week	657 (95)	1	1	1	1
1 – 99 minutes / week	27 (4)	1.71 (0.87 – 3.36)	1.91 (0.73 – 5.03)	2.01 (0.82– 4.95)	**2.99 (1.06 – 8.45)***
≥ 100 minutes / week	7 (1)	0.97 (0.21 – 4.48)	NC	1.05 (0.12– 8.91)	NC
Alcohols					
Yes vs No	104 (15)	0.93 (0.62 – 1.39)	0.81 (0.42 – 1.57)	1.07 (0.60 – 1.90)	0.75 (0.31 – 1.82)
0 minutes / week	593 (88)	1	1	1	1
1 – 99 minutes / week	64 (10)	1.03 (0.63 – 1.69)	1.02 (0.48 – 2.18)	0.56 (0.23– 1.35)	0.78 (0.27 – 2.29)
≥ 100 minutes / week	16 (2)	1.12 (0.45 – 2.80)	0.93 (0.20 – 4.26)	**4.40 (1.58 – 12.26)****	0.85 (0.11 – 6.75)
Bleach					
Yes vs No	204 (29)	0.91 (0.66 – 1.26)	0.86 (0.51 – 1.44)	1.21 (0.77– 1.90)	0.74 (0.37 – 1.47)
0 minutes / week	493 (75)	1	1	1	1
1 – 99 minutes / week	89 (14)	0.96 (0.63 – 1.48)	0.82 (0.40 – 1.69)	0.72 (0.35– 1.47)	0.26 (0.06 – 1.11)
≥ 100 minutes / week	75 (11)	0.88 (0.55 – 1.43)	0.80 (0.36 – 1.78)	**2.50 (1.41 – 4.43)****	1.36 (0.60 – 3.09)

Data are presented as OR (95% CI), unless otherwise indicated. ##: mean ratio (95% CI); OR: odds ratio; CI: confidence interval; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001; WRONS: Work-related ocular–nasal symptoms (ocular–nasal symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; WRAS: Work-related asthma symptoms (asthma symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; Adjusted for atopy, gender and smoking; NC: not calculable

Table 7.1.2: Respiratory symptoms associated with specific tasks in medical instrument cleaning and disinfection among health workers in the tertiary hospitals

	Prevalence (%)	**Asthma symptom score[##]**	**Asthma symptom score (≥2 vs 0-1)**	**WRONS**	**WRAS**
Prevalence (%) (n = 697)			91 (13)	109 (16)	48 (7)
Medical instruments cleaning and disinfection	301 (43)				
Tasks					
Medical instruments cleaning and disinfecting tasks[ǂ]	331 (48)	1.31 (0.97 – 1.75)	1.28 (0.81 – 2.03)	1.07 (0.70 – 1.64)	0.90 (0.49 – 1.65)
Manually disassembling instruments, removing/flushing gross contaminants					
Yes vs No	201 (29)	**1.41 (1.04 – 1.92)***	1.31 (0.81 – 2.12)	1.08 (0.69– 1.70)	1.14 (0.60 – 2.17)
0 minutes / week	496 (71)	1	1	1	1
1 – 99 minutes / week	133 (19)	**1.44 (1.01 – 2.07)***	1.42 (0.82 – 2.46)	0.78 (0.44– 1.39)	1.17 (0.55 – 2.47)
≥ 100 minutes / week	68 (10)	1.34 (0.84 – 2.14)	1.10 (0.51 – 2.37)	1.77 (0.95 – 3.29)	1.09 (0.40 – 2.92)
Diluting or mixing cleaning products					
Yes vs No	251 (36)	1.20 (0.89 – 1.61)	1.09 (0.68 – 1.74)	1.24 (0.81 – 1.90)	0.96 (0.51 – 1.78)
0 minutes / week	446 (64)	1	1	1	1
1 – 99 minutes / week	213 (31)	1.19 (0.87 – 1.63)	1.12 (0.69 – 1.82)	1.22 (0.78 – 1.91)	0.99 (0.52 – 1.90)
≥ 100 minutes / week	38 (5)	1.20 (0.65 – 2.23)	0.94 (0.34 – 2.57)	1.35 (0.56 – 3.24)	0.74 (0.17 – 3.26)
Changing sterilisation solutions					
Yes vs No	157 (23)	**1.40 (1.00 – 1.94)***	1.36 (0.81 – 2.29)	1.49 (0.93 – 2.38)	0.79 (0.37 – 1.70)
0 minutes / week	540 (78)	1	1	1	1
1 – 99 minutes / week	135 (19)	**1.48 (1.04 – 2.08)***	1.56 (0.92 – 2.68)	1.21 (0.72 – 2.04)	0.80 (0.36 – 1.78)
≥ 100 minutes / week	22 (3)	0.89 (0.37– 2.15)	0.34 (0.04 – 2.59)	**3.97 (1.55 – 10.15)****	0.75 (0.10 – 5.83)
Manually sterilise/disinfection of medical instruments					
Yes vs No	143 (21)	**1.45 (1.03 – 2.03)***	1.36 (0.80 – 2.31)	1.18 (0.71 – 1.96)	0.90 (0.42 – 1.94)
0 minutes / week	554 (80)	1	1	1	1
1 – 99 minutes / week	106 (15)	**1.52 (1.04 – 2.21)***	1.45 (0.81 – 2.60)	0.82 (0.44 – 1.53)	0.80 (0.33 – 1.97)
≥ 100 minutes / week	37 (5)	1.25 (0.68– 2.33)	1.11 (0.41 – 3.01)	**2.58 (1.20 – 5.55)***	1.22 (0.35 – 4.25)
Sterilise medical instruments using automated systems					
Yes vs No	15 (2)	1.84 (0.77 – 4.40)	2.39 (0.72 – 7.91)	1.38 (0.38 – 5.01)	2.41 (0.51 – 11.43)
0 minutes / week	682 (98)	1	1	1	1
1 – 99 minutes / week	8 (1)	1.78 (0.53 – 6.02)	2.21 (0.42 – 11.50)	NC	2.76 (0.31 – 24.29)
≥ 100 minutes / week	7 (1)	1.90 (0.55 – 6.57)	2.62 (0.48 – 14.39)	4.29 (0.94 – 19.62)	2.13 (0.24 – 18.76)

Data are presented as OR (95% CI), unless otherwise indicated. ##: mean ratio (95% CI); OR: odds ratio; CI: confidence interval; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001; WRONS: Work-related ocular–nasal symptoms (ocular–nasal symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; WRAS: Work-related asthma symptoms (asthma symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; ǂ: A combined variable consisting of 5 tasks involved in medical instruments cleaning and disinfection i.e. pre-cleaning of instruments by removing/flushing gross contaminants, diluting/mixing cleaning products, changing sterilization solutions, manually sterilize/disinfection of medical instruments and sterilize medical instruments using automated systems; Adjusted for atopy, gender and smoking; NC: not calculable

Table 7.2.1: Bronchial hyperresponsiveness and airway inflammation associated with specific chemicals in medical instrument cleaning and disinfection among health workers in the tertiary hospitals

	Prevalence (%)	**Dose-response slope (DRS)**[‡] (n = 239)	**NSBH** (n = 446)	**FeNO, ppb**[‡] (n = 654)	**FeNO≥ 50 ppb** (n = 654)
Prevalence (%)			57 (13)		41 (6)
Medical instruments cleaning and disinfection	301 (43)	1.02 (0.61 – 1.72)	0.77 (0.43 – 1.37)	1.06 (0.96 – 1.17)	1.34 (0.70 – 2.59)
Agents					
Ortho-phthalaldehyde					
Yes vs No	113 (16)	1.02 (0.56 – 1.86)	0.79 (0.37 – 1.70)	1.10 (0.96 – 1.25)	**2.81 (1.32 – 5.94)****
0 minutes / week	584 (86)	1	1	1	1
1 – 99 minutes / week	64 (10)	1.00 (0.46 – 2.16)	1.01 (0.40 – 2.57)	**1.19 (1.01 – 1.40)***	**3.73 (1.60 – 8.73)****
≥ 100 minutes / week	30 (4)	1.83 (0.56 – 6.05)	0.29 (0.04 – 2.21)	0.98 (0.78 – 1.23)	0.77 (0.10 – 6.02)
Glutaraldehyde					
Yes vs No	49 (7)	0.45 (0.03 – 6.65)	0.43 (0.10 – 1.86)	0.89 (0.73 – 1.07)	0.88 (0.26 – 3.02)
0 minutes / week	648 (94)	1	1	1	1
1 – 99 minutes / week	28 (4)	0.45 (0.03 – 6.65)	0.40 (0.05 – 3.08)	0.93 (0.73 – 1.18)	1.18 (0.26 – 5.30)
≥ 100 minutes / week	16 (2)	NC	NC	0.88 (0.64 – 1.23)	0.79 (0.10 – 6.35)
Enzymatic cleaners					
Yes vs No	113 (16)	1.03 (0.54 – 1.97)	0.73 (0.33 – 1.62)	1.12 (0.99 – 1.28)	**2.20 (1.04 – 4.65)***
0 minutes / week	584 (87)	1	1	1	1
1 – 99 minutes / week	46 (7)	1.37 (0.51 – 3.70)	1.54 (0.55 – 4.33)	1.18 (0.97 – 1.43)	**3.90 (1.53 – 9.98)****
≥ 100 minutes / week	43 (6)	1.14 (0.39 – 3.28)	0.21 (0.03 – 1.61)	1.00 (0.82 – 1.22)	0.98 (0.22– 4.37)
Chlorhexidine					
Yes vs No	84 (12)	1.13 (0.63 – 2.03)	1.31 (0.63 – 2.70)	**1.31 (1.13 – 1.51)*****	2.13 (0.91 – 4.99)
0 minutes / week	613 (91)	1	1	1	1
1 – 99 minutes / week	44 (7)	0.75 (0.33 – 1.68)	1.05 (0.35 – 3.18)	**1.38 (1.14 – 1.66)****	**2.91 (1.02 – 8.35)***
≥ 100 minutes / week	13 (2)	2.09 (0.71 – 6.20)	1.90 (0.50 – 7.27)	1.11 (0.79 – 1.55)	NC
Quaternary ammonium compounds					
Yes vs No	26 (4)	0.42 (0.15 – 1.13)	0.34 (0.04 – 2.62)	1.20 (0.94 – 1.53)	2.77 (0.75 – 10.21)
0 minutes / week	671 (97)	1	1	1	1
1 – 99 minutes / week	15 (2)	0.30 (0.08 – 1.08)	NC	1.26 (0.92 – 1.74)	**5.31 (1.32 – 21.28)***
≥ 100 minutes / week	3 (0)	1.39 (0.16 – 12.36)	2.93 (0.26 – 33.44)	1.50 (0.74 – 3.04)	NC

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; ‡: Geometric mean ratio (95% Confidence Interval); *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001;NSBH: nonspecific bronchial hyperresponsiveness; NSBH defined as any of the following two criteria: PD_{20} methacholine < 0.4 mg OR ≥12% and ≥ 200 ml increase in FEV_1 after administration of a bronchodilator; Adjusted for atopy, gender and smoking; NC: not calculable

Table 7.2.1 (contd.): Bronchial hyperresponsiveness and airway inflammation associated with specific chemicals in medical instrument cleaning and disinfection among health workers in the tertiary hospitals

	Prevalence (%)	**Dose-response slope (DRS)‡** (n = 239)	**NSBH** (n = 446)	**FeNO, ppb‡** (n = 654)	**FeNO≥ 50 ppb** (n = 654)
Prevalence (%)			57 (13)		41 (6)
Medical instruments cleaning and disinfection	301 (43)				
Agents					
Hydrogen peroxide					
Yes vs No	40 (6)	2.03 (0.72 – 5.74)	1.28 (0.42 – 3.89)	1.11 (0.91 – 1.37)	2.51 (0.90 – 7.04)
0 minutes / week	657 (95)	1	1	1	1
1 – 99 minutes / week	27 (4)	2.71 (0.80 – 9.20)	2.22 (0.68 – 7.23)	1.14 (0.88 – 1.46)	1.96 (0.54 – 7.06)
≥ 100 minutes / week	7 (1)	1.51 (0.17 – 13.42)	NC	0.97 (0.61 – 1.55)	4.29 (0.46 – 40.10)
Alcohols					
Yes vs No	104 (15)	0.89 (0.45 – 1.75)	0.60 (0.25 – 1.47)	1.01 (0.89 – 1.16)	1.42 (0.62 – 3.24)
0 minutes / week	593 (88)	1	1	1	1
1 – 99 minutes / week	64 (10)	0.96 (0.34 – 2.74)	0.39 (0.09 – 1.70)	1.01 (0.85 – 1.19)	1.75 (0.68 – 4.49)
≥ 100 minutes / week	16 (2)	1.76 (0.41 – 7.54)	1.93 (0.51 – 7.38)	1.21 (0.89 – 1.65)	1.25 (0.15 – 10.17)
Bleach					
Yes vs No	204 (29)	0.97 (0.51 – 1.85)	0.78 (0.41 – 1.50)	0.90 (0.81 – 1.00)	0.71 (0.34 – 1.50)
0 minutes / week	493 (75)	1	1	1	1
1 – 99 minutes / week	89 (14)	0.96 (0.41 – 2.29)	0.55 (0.19 – 1.61)	0.94 (0.81– 1.08)	0.67 (0.23 – 1.98)
≥ 100 minutes / week	75 (11)	1.28 (0.32 – 5.11)	1.05 (0.43 – 2.52)	0.87 (0.75– 1.02)	0.72 (0.24 – 2.13)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; ‡: Geometric mean ratio (95% Confidence Interval); *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001;NSBH: nonspecific bronchial hyperresponsiveness;NSBH defined as any of the following two criteria: PD_{20} methacholine < 0.4 mg OR ≥12% and ≥ 200 ml increase in FEV_1 after administration of a bronchodilator; Adjusted for atopy, gender and smoking; NC: not calculable

Table 7.2.2: Bronchial hyperresponsiveness and airway inflammation associated with specific tasks in medical instrument cleaning and disinfection among health workers in the tertiary hospitals

	Prevalence (%)	**Dose-response slope (DRS)[‡]** (n = 239)	**NSBH** (n = 446)	**FeNO, ppb[‡]** (n = 654)	**FeNO≥ 50 ppb** (n = 654)
Prevalence (%)			57 (13)		41 (6)
Medical instruments cleaning and disinfection	301 (43)				
Tasks					
Medical instruments cleaning and disinfecting tasks[#]	331 (48)	0.89 (0.51 – 1.54)	1.31 (0.73 – 2.32)	**1.13 (1.03 – 1.25)***	1.55 (0.80 – 3.02)
Manually disassembling instruments, removing/flushing gross contaminants					
Yes vs No	201 (29)	1.01 (0.59 – 1.72)	1.01 (0.55 – 1.85)	**1.14 (1.03 – 1.27)***	1.69 (0.85 – 3.37)
0 minutes / week	496 (71)	1	1	1	1
1 – 99 minutes / week	133 (19)	0.95 (0.52 – 1.71)	1.09 (0.55 – 2.16)	**1.18 (1.05 – 1.34)****	2.02 (0.94 – 4.37)
≥ 100 minutes / week	68 (10)	1.20 (0.49 – 2.96)	0.85 (0.32 – 2.30)	1.06 (0.90 – 1.26)	1.18 (0.39 – 3.57)
Diluting or mixing cleaning products					
Yes vs No	251 (36)	0.95 (0.57 – 1.59)	1.12 (0.64 – 1.98)	1.06 (0.96 – 1.17)	1.32 (0.68 – 2.56)
0 minutes / week	446 (64)	1	1	1	1
1 – 99 minutes / week	213 (31)	1.03 (0.60 – 1.75)	1.14 (0.63 – 2.05)	1.03 (0.93 – 1.14)	1.26 (0.63 – 2.54)
≥ 100 minutes / week	38 (5)	0.61 (0.22 – 1.69)	0.99 (0.28 – 3.54)	1.23 (0.99 – 1.53)	1.70 (0.47 – 6.18)
Changing sterilisation solutions					
Yes vs No	157 (23)	0.96 (0.53 – 1.75)	0.73 (0.36 – 1.47)	1.05 (0.93 – 1.17)	1.24 (0.58 – 2.64)
0 minutes / week	540 (78)	1	1	1	1
1 – 99 minutes / week	135 (19)	0.85 (0.45 – 1.60)	0.76 (0.36 – 1.58)	1.02 (0.91 – 1.16)	1.30 (0.59 – 2.86)
≥ 100 minutes / week	22 (3)	1.91 (0.49 – 7.46)	0.51 (0.07 – 4.04)	1.19 (0.90 – 1.57)	0.89 (0.11 – 7.08)
Manually sterilise/disinfection of medical instruments					
Yes vs No	143 (21)	0.71 (0.42 – 1.21)	1.03 (0.54 – 1.97)	**1.16 (1.03 – 1.31)***	1.60 (0.74 – 3.46)
0 minutes / week	554 (80)	1	1	1	1
1 – 99 minutes / week	106 (15)	0.56 (0.32 – 1.00)	0.98 (0.47 – 2.02)	**1.16 (1.01 – 1.32)***	1.92 (0.86 – 4.32)
≥ 100 minutes / week	37 (5)	1.98 (0.69 – 5.68)	1.19 (0.39 – 3.67)	1.18 (0.95– 1.48)	0.64 (0.08 – 4.95)
Sterilise medical instruments using automated systems					
Yes vs No	15 (2)	1.26 (0.41 – 3.84)	1.17 (0.25 – 5.44)	1.33 (0.97 – 1.83)	2.60 (0.53 – 12.77)
0 minutes / week	682 (98)	1	1	1	1
1 – 99 minutes / week	8 (1)	0.49 (0.12 – 2.09)	NC	1.18 (0.76 – 1.82)	2.54 (0.27 – 24.08)
≥ 100 minutes / week	7 (1)	4.59 (0.85 – 24.97)	2.63 (0.49 – 14.08)	1.53 (0.97 – 2.43)	2.66 (0.29 – 24.39)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; ‡: Geometric mean ratio (95% Confidence Interval); *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001;NSBH: nonspecific bronchial hyperresponsiveness; NSBH defined as any of the following two criteria: PD_{20} methacholine < 0.4 mg OR ≥12% and ≥ 200 ml increase in FEV_1 after administration of a bronchodilator; #: A combined variable consisting of 5 tasks involved in medical instruments cleaning and disinfectioni.e. pre-cleaning of instruments by removing/flushing gross contaminants, diluting/mixing cleaning products, changing sterilization solutions, manually sterilize/disinfection of medical instruments and sterilize medical instruments using automated systems; Adjusted for atopy, gender and smoking; NC: not calculable

7.3.2. Asthma-related outcomes associated with fixed surfaces cleaning and disinfection

A higher mean asthma symptom score (mean ratio = 1.52; 95% CI: 1.04 – 2.22) was observed for HWs who used bleach for fixed surface cleaning and disinfection between 1-99 minutes per week (**Table 7.3.1**). The use of chemical products containing ammonia was strongly associated more symptomatic HWs (≥ 2 asthma-related symptoms) (OR= 2.76; 95% CI: 1.11 – 6.90) compared to those that were less or not symptomatic. Furthermore, these symptomatic HWs were also more likely to use sprays rather than wipes (OR = 5.58; 95% CI: 2.04 – 15.24) for fixed surfaces cleaning and disinfection (**Table 7.3.2**). Finally, while no significant associations were observed between specific chemicals used in fixed surface cleaning, an increased odds of having bronchial hyperresponsiveness (higher DRS) was observed among HWs that performed terminal cleaning of patient rooms (GM ratio = 1.70; 95% CI: 1.01 – 2.88) (**Table 7.4.2**), and increasing FeNO levels were positively associated with spraying of deodorants/disinfectants (GM ratio = 1.20; 95% CI: 1.08 – 1.33).

Table 7.3.1: Respiratory symptoms associated with specific chemicals used in fixed surface cleaning and disinfection among health workers in the tertiary hospitals

	Prevalence (%)	Asthma symptom score##	Asthma symptom score (≥2 vs 0-1)	WRONS	WRAS
Prevalence (%) (n = 697)			91 (13)	109 (16)	48 (7)
Fixed surfaces cleaning and disinfection	572 (82)	1.40 (0.92 – 2.13)	1.56 (0.77 – 3.15)	0.83 (0.48 – 1.42)	0.90 (0.40 – 2.02)
Agents					
Ammonia					
Yes vs No	73 (11)	0.96 (0.61 – 1.52)	1.06 (0.53 – 2.11)	0.87 (0.44 – 1.75)	0.15 (0.02 – 1.14)
0 minutes / week	624 (95)	1	1	1	1
1 – 99 minutes / week	24 (4)	1.60 (0.81 – 3.17)	**2.76 (1.11 – 6.90)***	1.29 (0.47 – 3.58)	NC
≥ 100 minutes / week	9 (1)	0.34 (0.06 – 1.85)	NC	0.62 (0.08 – 5.20)	NC
Bleach					
Yes vs No	474 (68)	1.10 (0.80– 1.52)	1.02 (0.62 – 1.69)	0.94 (0.60 – 1.47)	1.09 (0.56 – 2.14)
0 minutes / week	223 (40)	1	1	1	1
1 – 99 minutes / week	154 (27)	**1.52 (1.04 – 2.22)***	1.52 (0.84 – 2.75)	0.77 (0.42 – 1.40)	0.66 (0.25 – 1.71)
≥ 100 minutes / week	189 (33)	0.95 (0.65– 1.40)	0.89 (0.48 – 1.66)	1.35 (0.80 – 2.26)	1.58 (0.75 – 3.32)

Data are presented as OR (95% CI), unless otherwise indicated. ##: mean ratio (95% CI); OR: odds ratio; CI: confidence interval; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001; WRONS: Work-related ocular–nasal symptoms (ocular–nasal symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; WRAS: Work-related asthma symptoms (asthma symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; Adjusted for atopy, gender and smoking; NC: not calculable

Table 7.3.2: Respiratory symptoms associated with specific tasks used in fixed surface cleaning and disinfection among health workers in the tertiary hospitals

	Prevalence (%)	Asthma symptom score##	Asthma symptom score (≥2 vs 0-1)	WRONS	WRAS
Prevalence (%) (n = 697)			91 (13)	109 (16)	48 (7)
Fixed surfaces cleaning and disinfection	572 (82)				
Tasks					
Use more sprays vs more wipes	18 (3)	**3.00 (1.50 – 5.98)****	**5.58 (2.04 – 15.24)****	0.59 (0.13 – 2.66)	1.65 (0.35 – 7.81)
Manually mix, refill, or empty cleaning/disinfecting products					
Yes vs No	354 (51)	1.20 (0.89 – 1.61)	0.98 (0.62 – 1.55)	1.37 (0.89 – 2.11)	1.09 (0.59 – 2.00)
0 minutes / week	343 (59)	1	1	1	1
1 – 99 minutes / week	221 (38)	1.34 (0.96 – 1.87)	1.01 (0.60 – 1.69)	1.41 (0.88 – 2.27)	1.05 (0.52 – 2.10)
≥ 100 minutes / week	19 (3)	1.64 (0.71– 3.79)	1.13 (0.31 – 4.14)	2.24 (0.77 – 6.56)	NC
Spray deodorant/ disinfectant					
Yes vs No	208 (30)	**1.46 (1.08 – 1.99)***	1.54 (0.95 – 2.47)	1.06 (0.67 – 1.68)	0.87 (0.44 – 1.70)
0 minutes / week	489 (78)	1	1	1	1
1 – 99 minutes / week	128 (20)	**1.76 (1.23 – 2.52)****	**2.00 (1.17– 3.44)***	1.24 (0.73 – 2.09)	0.88 (0.39 – 1.99)
≥ 100 minutes / week	12 (2)	0.92 (0.29– 2.89)	0.66 (0.08 – 5.45)	0.48 (0.06 – 3.76)	NC
Clean instruments or equipment					
Yes vs No	404 (58)	1.22 (0.91 – 1.64)	1.12 (0.70 – 1.78)	1.01 (0.66 – 1.55)	0.83 (0.45 – 1.51)
0 minutes / week	293 (51)	1	1	1	1
1 – 99 minutes / week	170 (29)	1.30 (0.90 – 1.88)	0.97 (0.53 – 1.78)	1.02 (0.60 – 1.73)	0.73 (0.32 – 1.64)
≥ 100 minutes / week	114 (20)	1.17 (0.77 – 1.78)	1.40 (0.74 – 2.62)	1.40 (0.80 – 2.46)	0.87 (0.37 – 2.05)
Terminal cleaning of patient rooms					
Yes vs No	159 (23)	1.05 (0.74 – 1.47)	1.05 (0.62 – 1.79)	0.64 (0.37 – 1.11)	0.88 (0.42 – 1.83)
0 minutes / week	538 (87)	1	1	1	1
1 – 99 minutes / week	59 (10)	1.24 (0.76 – 2.04)	1.26 (0.59 – 2.69)	0.90 (0.42 – 1.92)	0.91 (0.31 – 2.70)
≥ 100 minutes / week	21 (3)	1.29 (0.58 – 2.88)	1.51 (0.47 – 4.87)	0.53 (0.12 – 2.34)	0.64 (0.08 – 4.94)

Data are presented as OR (95% CI), unless otherwise indicated. ##: mean ratio (95% CI); OR: odds ratio; CI: confidence interval; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001; WRONS: Work-related ocular–nasal symptoms (ocular–nasal symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; WRAS: Work-related asthma symptoms (asthma symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; Adjusted for atopy, gender and smoking; NC: not calculable

Table 7.4.1: Bronchial hyperresponsiveness and airway inflammation associated with specific chemicals used in fixed surface cleaning and disinfection among health workers in the tertiary hospitals

	Prevalence (%)	**Dose-response slope (DRS)[‡]** (n = 239)	**NSBH** (n = 446)	**FeNO, ppb[‡]** (n = 654)	**FeNO≥ 50 ppb** (n = 654)
Prevalence (%)			57 (13)		41 (6)
Fixed surfaces cleaning and disinfection	572 (82)	1.06 (0.42 – 2.69)	0.68 (0.33 – 1.43)	1.12 (0.98 – 1.28)	1.05 (0.44 – 2.54)
Agents					
Ammonia					
Yes vs No	73 (11)	0.82 (0.43 – 1.56)	0.59 (0.22 – 1.56)	1.00 (0.86 – 1.17)	1.30 (0.47 – 3.54)
0 minutes / week	624 (95)	1	1	1	1
1 – 99 minutes / week	24 (4)	0.60 (0.21 – 1.72)	0.32 (0.04 – 2.50)	1.12 (0.87 – 1.45)	0.65 (0.08 – 5.07)
≥ 100 minutes / week	9 (1)	0.41 (0.07 – 2.26)	NC	0.97 (0.62 – 1.50)	3.17 (0.32 – 31.04)
Bleach					
Yes vs No	474 (68)	0.99 (0.54 – 1.79)	0.95 (0.51 – 1.76)	1.05 (0.95 – 1.17)	1.12 (0.54 – 2.34)
0 minutes / week	223 (40)	1	1	1	1
1 – 99 minutes / week	154 (27)	0.73 (0.38 – 1.41)	0.73 (0.31 – 1.68)	1.14 (0.99 – 1.30)	1.48 (0.62 – 3.52)
≥ 100 minutes / week	189 (33)	0.80 (0.38 – 1.67)	0.65 (0.29 – 1.46)	1.03 (0.91 – 1.17)	1.32 (0.58 – 3.04)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; ‡: Geometric mean ratio (95% Confidence Interval); *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001;NSBH: nonspecific bronchial hyperresponsiveness;NSBH defined as any of the following two criteria: PD_{20} methacholine < 0.4 mg OR ≥12% and ≥ 200 ml increase in FEV_1 after administration of a bronchodilator; Adjusted for atopy, gender and smoking; NC: not calculable

Table 7.4.2: Bronchial hyperresponsiveness and airway inflammation associated with specific tasks used in fixed surface cleaning and disinfection among health workers in the tertiary hospitals

	Prevalence (%)	**Dose-response slope (DRS)[‡]** (n = 239)	**NSBH** (n = 446)	**FeNO, ppb[‡]** (n = 654)	**FeNO≥ 50 ppb** (n = 654)
Prevalence (%)			57 (13)		41 (6)
Fixed surfaces cleaning and disinfection	572 (82)				
Tasks					
Use more sprays vs more wipes	18 (3)	1.04 (0.27 – 4.08)	NC	0.97 (0.72 – 1.30)	0.70 (0.09 – 5.63)
Manually mix, refill, or empty cleaning/disinfecting products					
Yes vs No	354 (51)	0.93 (0.52 – 1.66)	1.14 (0.64 – 2.04)	1.09 (0.98 – 1.20)	1.31 (0.67 – 2.57)
0 minutes / week	343 (59)	1	1	1	1
1 – 99 minutes / week	221 (38)	0.86 (0.48 – 1.55)	0.98 (0.50 – 1.91)	1.08 (0.97 – 1.21)	1.06 (0.49 – 2.32)
≥ 100 minutes / week	19 (3)	0.83 (0.26 – 2.72)	0.47 (0.06 – 3.85)	1.18 (0.88 – 1.59)	3.18 (0.80 – 12.62)
Spray deodorant/ disinfectant					
Yes vs No	208 (30)	0.79 (0.47 – 1.32)	1.01 (0.55 – 1.82)	**1.20 (1.08 – 1.33)****	1.76 (0.89 – 3.45)
0 minutes / week	489 (78)	1	1	1	1
1 – 99 minutes / week	128 (20)	0.77 (0.45 – 1.34)	0.80 (0.39 – 1.67)	**1.23 (1.09– 1.39)****	1.81 (0.82 – 3.98)
≥ 100 minutes / week	12 (2)	**0.15 (0.03 – 0.77)***	0.90 (0.11 – 7.62)	1.05 (0.74– 1.49)	1.70 (0.20 – 14.24)
Clean instruments or equipment					
Yes vs No	404 (58)	0.93 (0.50 – 1.73)	0.98 (0.55 – 1.74)	1.08 (0.98 – 1.19)	1.56 (0.78 – 3.12)
0 minutes / week	293 (51)	1	1	1	1
1 – 99 minutes / week	170 (29)	0.83 (0.41 – 1.65)	0.82 (0.39 – 1.74)	1.09 (0.97 – 1.24)	1.45 (0.61 – 3.44)
≥ 100 minutes / week	114 (20)	0.99 (0.44 – 2.24)	1.01 (0.46 – 2.22)	1.13 (0.99 – 1.30)	2.23 (0.95 – 5.26)
Terminal cleaning of patient rooms					
Yes vs No	159 (23)	**1.70 (1.01 – 2.88)***	1.20 (0.65 – 2.24)	1.10 (0.98 – 1.24)	1.32 (0.61 – 2.84)
0 minutes / week	538 (87)	1	1	1	1
1 – 99 minutes / week	59 (10)	1.10 (0.53 – 2.30)	1.00 (0.36 – 2.77)	1.08 (0.90 – 1.28)	1.41 (0.46 – 4.29)
≥ 100 minutes / week	21 (3)	2.42 (0.70 – 8.30)	0.43 (0.05 – 3.35)	1.08 (0.82 – 1.42)	0.93 (0.12 – 7.41)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; ‡: Geometric mean ratio (95% Confidence Interval); *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001; NSBH: nonspecific bronchial hyperresponsiveness; NSBH defined as any of the following two criteria: PD_{20} methacholine < 0.4 mg OR ≥12% and ≥ 200 ml increase in FEV_1 after administration of a bronchodilator; Adjusted for atopy, gender and smoking

7.3.3. Asthma-related outcomes associated with specimen preparation products

A higher mean asthma symptom score (mean ratio = 1.55; 95% CI: 1.07 – 2.26) was observed for HWs that used formalin (10%) solution to prepare specimens for up to 99 minutes per week (**Table 7.5**). Furthermore, HWs with increasing FeNO levels were also more likely to use formalin (10%) solution (GM ratio = 1.19; 95% CI: 1.06 – 1.34) for tissue fixation and alcohol-based cytological fixative spray (GM ratio = 1.33; 95% CI: 1.04 – 1.71) for similar durations of time (**Table 7.6**).

Table 7.5: Respiratory symptoms associated with specific chemicals used in specimen preparation among health workers in the tertiary hospitals

	Prevalence (%)	Asthma symptom score##	Asthma symptom score (≥2 vs 0-1)	WRONS	WRAS
Prevalence (%) (n = 697)			91 (13)	109 (16)	48 (7)
Specimen preparation products	157 (23)	1.36 (0.98 – 1.90)	1.21 (0.72 – 2.04)	1.43 (0.89 – 2.29)	1.27 (0.65 – 2.48)
Formalin 10% in normal saline					
Yes vs No	146 (21)	1.34 (0.96 – 1.88)	1.17 (0.68 – 1.99)	1.39 (0.86 – 2.24)	1.21 (0.61 – 2.42)
0 minutes / week	549 (82)	1	1	1	1
1 – 99 minutes / week	110 (17)	**1.55 (1.07 – 2.26)***	1.26 (0.70 – 2.27)	1.56 (0.93 – 2.64)	1.22 (0.56 – 2.64)
≥ 100 minutes / week	5 (1)	0.67 (0.10 – 4.29)	NC	1.51 (0.17 – 13.77)	NC
Alcohol-based cytological fixative spray					
Yes vs No	25 (4)	1.34 (0.66 – 2.73)	1.67 (0.63 – 4.43)	2.10 (0.84 – 5.24)	1.67 (0.47 – 5.92)
0 minutes / week	672 (98)	1	1	1	1
1 – 99 minutes / week	17 (2)	1.56 (0.67 – 3.66)	1.28 (0.71 – 2.30)	2.30 (0.78 – 6.73)	1.67 (0.36 – 7.78)
≥ 100 minutes / week	0 (0)	NC	NC	NC	NC
Solvents					
Yes vs No	2 (0)	3.27 (0.41 – 25.87)	4.64 (0.28 – 77.99)	NC	NC
0 minutes / week	695 (100)	1	1	1	1
1 – 99 minutes / week	2 (0)	3.27 (0.41 – 25.87)	4.64 (0.28 – 77.99)	NC	NC
≥ 100 minutes / week	0 (0)	NC	NC	NC	NC

Data are presented as OR (95% CI), unless otherwise indicated. ##: mean ratio (95% CI); OR: odds ratio; CI: confidence interval; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001; WRONS: Work-related ocular–nasal symptoms (ocular–nasal symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; WRAS: Work-related asthma symptoms (asthma symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; Adjusted for atopy, gender and smoking; NC: not calculable

Table 7.6: Bronchial hyperresponsiveness and airway inflammation associated with specific chemicals used in specimen preparation among health workers in the tertiary hospitals

	Prevalence (%)	**Dose-response slope (DRS)[ǂ]** (n = 239)	**NSBH** (n = 446)	**FeNO, ppb[ǂ]** (n = 654)	**FeNO≥ 50 ppb** (n = 654)
Prevalence (%)			57 (13)		41 (6)
Specimen preparation products	157 (23)	1.08 (0.61 – 1.91)	1.77 (0.97 – 3.22)	**1.20 (1.07 – 1.35)****	1.25 (0.58 – 2.67)
Formalin 10% in normal saline					
Yes vs No	146 (21)	1.06 (0.59 – 1.91)	1.76 (0.96 – 3.23)	**1.19 (1.06 – 1.34)****	1.15 (0.52 – 2.52)
0 minutes / week	549 (83)	1	1	1	1
1 – 99 minutes / week	110 (16)	0.99 (0.51 – 1.92)	1.86 (0.96 – 3.61)	**1.20 (1.05 – 1.38)****	1.32 (0.58 –3.00)
≥ 100 minutes / week	5 (1)	0.97 (0.07 – 14.01)	NC	1.18 (0.68– 2.04)	NC
Alcohol-based cytological fixative spray					
Yes vs No	25 (4)	0.72 (0.26 – 1.97)	0.34 (0.04 – 2.60)	**1.33 (1.04 – 1.71)***	2.27 (0.62 – 8.35)
0 minutes / week	672 (98)	1	1	1	1
1 – 99 minutes / week	17 (2)	0.83 (0.28 – 2.45)	0.41 (0.05 – 3.18)	**1.55 (1.15 – 2.09)****	3.62 (0.93 – 14.17)
≥ 100 minutes / week	0 (0)	NC	NC	NC	NC
Solvents					
Yes vs No	2 (0)	6.36 (0.43 – 93.39)	NC	0.85 (0.36 – 2.02)	NC
0 minutes / week	695 (100)	1	1	1	1
1 – 99 minutes / week	2 (0)	6.36 (0.43 – 93.39)	NC	0.85 (0.36 – 2.02)	NC
≥ 100 minutes / week	0 (0)	NC	NC	NC	NC

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; ǂ: Geometric mean ratio (95% Confidence Interval); *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001;NSBH: nonspecific bronchial hyperresponsiveness;NSBH defined as any of the following two criteria: PD_{20} methacholine < 0.4 mg OR ≥12% and ≥ 200 ml increase in FEV_1 after administration of a bronchodilator; Adjusted for atopy, gender and smoking; NC: not calculable

7.3.4. Asthma-related outcomes associated with patients' skin/wound cleaning and disinfection

Health workers that were more symptomatic (≥ 2 asthma-related symptoms) were more likely to perform patient care activities such as disinfecting skin areas on patients prior to procedure (OR = 2.36; 95% CI: 1.15 – 4.81), cleaning and disinfecting wounds (OR = 3.21; 95% CI: 1.21 – 8.50) and removing adhesives from patients skin using solvents (OR = 3.47; 95% CI: 1.06 – 11.36) (**Table 7.7**). This relationship showed a clear dose-response trend with those who performed patient care activities for ≥ 100 minutes per week having higher odds of being more symptomatic. A strong association was also observed between the presence of WRONS among HWs involved in disinfecting skin areas on patients prior to a procedure (OR = 2.30; 95% CI: 1.20 – 4.41) as well as between WRAS and applying wound dressings (OR = 3.60; 95% CI: 1.08 – 11.94).

While no associations were observed for bronchial hyperresponsiveness, weak exposure-response relationships were observed between increasing FeNO levels and most tasks including disinfecting skin areas on patients prior to procedure (GM ratio = 1.23; 95% CI: 1.03 – 1.47), cleaning and disinfecting wounds (GM ratio = 1.41; 95% CI: 1.09 – 1.82), applying wound dressings (GM ratio = 1.22; 95% CI: 1.00 – 1.49), using adhesives (GM ratio = 1.16; 95% CI: 1.03 – 1.30) as well as removing adhesives from patient's skin using solvents (GM ratio = 1.24; 95% CI: 1.09 – 1.42), mostly for durations up to 99 minutes per week (**Table 7.8**).

Table 7.7: Respiratory symptoms associated with specific chemicals and tasks used in patients' skin/wound cleaning and disinfection among health workers in the tertiary hospitals

	Prevalence (%)	Asthma symptoms score##	Asthma symptoms (≥2 vs 0-1)	WRONS	WRAS
Prevalence (%) (n = 697)			91 (13)	109 (16)	48 (7)
Patients' skin/wound cleaning and disinfection	327 (47)	1.23 (0.92 – 1.64)	1.17 (0.74 – 1.85)	1.03 (0.68 – 1.57)	0.71 (0.39 – 1.31)
Disinfect skin areas on patients prior to procedure					
Yes vs No	253 (36)	**1.37 (1.02 – 1.83)***	1.46 (0.92 – 2.31)	**1.53 (1.00 – 2.34)***	0.79 (0.42 – 1.50)
0 minutes / week	444 (74)	1	1	1	1
1 – 99 minutes / week	96 (16)	1.33 (0.87 – 2.02)	1.26 (0.65 – 2.45)	1.39 (0.76 – 2.54)	1.00 (0.42 – 2.39)
≥ 100 minutes / week	58 (10)	1.55 (0.94 – 2.57)	**2.36 (1.15 – 4.81)***	**2.30 (1.20 – 4.41)***	0.47 (0.11 – 2.03)
Clean and disinfect wounds					
Yes vs No	162 (23)	1.17 (0.84 – 1.63)	1.19 (0.72– 1.99)	1.02 (0.63– 1.66)	1.03 (0.51 – 2.05)
0 minutes / week	535 (90)	1	1	1	1
1 – 99 minutes / week	39 (6)	0.98 (0.52 – 1.88)	0.88 (0.32– 2.44)	0.31 (0.07 – 1.30)	0.36 (0.05 – 2.72)
≥ 100 minutes / week	22 (4)	1.81 (0.84 – 3.88)	**3.21 (1.21 – 8.50)***	2.42 (0.95 – 6.15)	2.55 (0.80 – 8.08)
Apply wound dressing					
Yes vs No	143 (21)	1.19 (0.84 – 1.68)	1.10 (0.64 – 1.88)	1.29 (0.79 – 2.11)	1.08 (0.53– 2.19)
0 minutes / week	554 (90)	1	1	1	1
1 – 99 minutes / week	44 (7)	1.14 (0.63 – 2.06)	0.85 (0.32– 2.30)	0.76 (0.29 – 2.00)	0.63 (0.15 – 2.74)
≥ 100 minutes / week	18 (3)	1.34 (0.57 – 3.15)	2.55 (0.88 – 7.37)	2.15 (0.74 – 6.26)	**3.60 (1.08 – 11.94)***
Use adhesives					
Yes vs No	279 (40)	**1.36 (1.02 – 1.83)***	1.42 (0.90 – 2.25)	1.13 (0.74 – 1.73)	0.89 (0.48 – 1.65)
0 minutes / week	418 (69)	1	1	1	1
1 – 99 minutes / week	154 (26)	**1.55 (1.10 – 2.18)***	1.44 (0.83– 2.51)	1.17 (0.71 – 1.95)	0.53 (0.21 – 1.31)
≥ 100 minutes / week	30 (5)	1.16 (0.59 – 2.30)	1.89 (0.72– 5.02)	2.04 (0.86 – 4.83)	2.47 (0.86 – 7.09)
Use adhesive removing solvents					
Yes vs No	197 (28)	**1.50 (1.10 – 2.04)***	1.43 (0.88 – 2.31)	0.91 (0.57 – 1.46)	0.62 (0.30– 1.29)
0 minutes / week	500 (81)	1	1	1	1
1 – 99 minutes / week	105 (17)	**1.74 (1.19 – 2.54)****	1.38 (0.75 – 2.53)	0.88 (0.48 – 1.61)	**0.23 (0.05 – 0.98)***
≥ 100 minutes / week	14 (2)	1.63 (0.66 – 4.04)	**3.47 (1.06 – 11.36)***	2.06 (0.62 – 6.84)	2.24 (0.45 – 11.11)

Data are presented as OR (95% CI), unless otherwise indicated. ##: mean ratio (95% CI); OR: odds ratio; CI: confidence interval; *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001; WRONS: Work-related ocular–nasal symptoms (ocular–nasal symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; WRAS: Work-related asthma symptoms (asthma symptoms experienced at work in the past 12 months that gets better when away from work OR worsen on return to work; Adjusted for atopy, gender and smoking

Table 7.8: Bronchial hyperresponsiveness and airway inflammation associated with specific chemicals and tasks used in patients' skin/wound cleaning and disinfection among health workers in the tertiary hospitals

	Prevalence (%)	**Dose-response slope (DRS)[ǂ]** (n = 239)	**NSBH** (n = 446)	**FeNO, ppb[ǂ]** (n = 654)	**FeNO≥ 50 ppb** (n = 654)
Prevalence (%)			57 (13)		41 (6)
Patients' skin/wound cleaning and disinfection	327 (47)	0.74 (0.42 – 1.28)	1.28 (0.72 – 2.26)	**1.16 (1.06 – 1.28)****	1.55 (0.80 – 3.00)
Disinfect skin areas on patients prior to procedure					
Yes vs No	253 (36)	0.83 (0.50 – 1.40)	1.40 (0.79 – 2.47)	1.08 (0.98– 1.19)	0.94 (0.47 – 1.86)
0 minutes / week	444 (74)	1	1	1	1
1 – 99 minutes / week	96 (16)	0.80 (0.42 – 1.53)	1.61 (0.77 – 3.40)	1.11 (0.96– 1.28)	0.50 (0.15 – 1.70)
≥ 100 minutes / week	58 (10)	0.46 (0.15 – 1.39)	0.93 (0.30 – 2.83)	**1.23 (1.03 – 1.47)***	1.95 (0.75 – 5.08)
Clean and disinfect wounds					
Yes vs No	162 (23)	0.95 (0.56 – 1.60)	1.65 (0.92 – 2.97)	**1.14 (1.02 – 1.28)***	**2.36 (1.19 – 4.68)***
0 minutes / week	535 (90)	1	1	1	1
1 – 99 minutes / week	39 (6)	0.44 (0.16 – 1.18)	1.33 (0.43 – 4.14)	1.15 (0.94– 1.40)	0.59 (0.08– 4.56)
≥ 100 minutes / week	22 (4)	0.91 (0.27 – 3.08)	2.27 (0.69 – 7.47)	**1.41 (1.09 – 1.82)****	**7.36 (2.51 – 21.58)*****
Apply wound dressing					
Yes vs No	143 (21)	0.76 (0.44 – 1.30)	0.91 (0.47 – 1.76)	1.04 (0.92 – 1.17)	0.91 (0.40 – 2.07)
0 minutes / week	554 (90)	1	1	1	1
1 – 99 minutes / week	44 (7)	0.77 (0.31 – 1.90)	1.23 (0.44 – 3.41)	**1.22 (1.00 – 1.49)***	1.81 (0.58 – 5.61)
≥ 100 minutes / week	18 (3)	0.47 (0.13 – 1.68)	NC	0.99 (0.74 – 1.33)	NC
Use adhesives					
Yes vs No	279 (40)	0.76 (0.44 – 1.30)	1.25 (0.71 – 2.20)	1.10 (1.00 – 1.21)	1.51 (0.79 – 2.91)
0 minutes / week	418 (69)	1	1	1	1
1 – 99 minutes / week	154 (26)	0.72 (0.40 – 1.30)	1.08 (0.54 – 2.16)	**1.16 (1.03 – 1.30)***	1.82 (0.86 – 3.81)
≥ 100 minutes / week	30 (5)	1.01 (0.30 – 3.36)	2.68 (0.87 – 8.23)	1.09 (0.87– 1.38)	0.64 (0.08 – 4.99)
Use adhesive removing solvents					
Yes vs No	197 (28)	0.89 (0.53 – 1.50)	1.09 (0.61 – 1.97)	**1.15 (1.04 – 1.28)****	1.45 (0.72 – 2.91)
0 minutes / week	500 (81)	1	1	1	1
1 – 99 minutes / week	105 (17)	0.88 (0.49 – 1.58)	1.01 (0.48 – 2.11)	**1.24 (1.09 – 1.42)****	2.03 (0.92 – 4.49)
≥ 100 minutes / week	14 (2)	1.03 (0.25 – 4.32)	1.30 (0.27 – 6.28)	1.04 (0.75 – 1.459)	NC

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; ǂ: Geometric mean ratio (95% Confidence Interval); *: p-value < 0.05; **: p-value < 0.01; ***: p-value < 0.001;NSBH: nonspecific bronchial hyperresponsiveness;NSBH defined as any of the following two criteria: PD_{20} methacholine < 0.4 mg OR ≥12% and ≥ 200 ml increase in FEV_1 after administration of a bronchodilator; Adjusted for atopy, gender and smoking; NC: not calculable

7.4. DISCUSSION

This study has identified a number of cleaning agents and tasks that are positively associated with asthma-related outcomes (asthma symptoms, bronchial hyperresponsiveness and FeNO) and work-related ocular-nasal symptoms. This consistent association with multiple asthma parameters suggests overall consistency and confidence in this relationship. Furthermore, there was also some specificity in these relationships in that consistent associations were more prominent for certain medical instrument cleaning agents (OPA, QACs and enzymatic cleaners) and tasks (pre-cleaning of medical instruments, changing sterilisation solutions and manual disinfection of medical instruments) as well as certain patient care activities (disinfecting patients' skin before procedure, cleaning/disinfecting wounds, applying wound dressing, using adhesives and adhesive removing solvents). A particularly pronounced dose-response relationship was observed between WRONS and medical instrument cleaning agents associated with asthma and tasks. Furthermore, a strong association was observed between higher asthma symptom scores and use of more sprays than wipes for fixed surface cleaning activities.

In this study, positive dose-response relationships (based on frequency duration measure) were observed between WRONS and specific agents (OPA, glutaraldehdye, QACs, enzymatic cleaners, alcohols and bleach) used for cleaning and disinfection of medical instruments. Similar relationships were observed between WRONS and specific cleaning and disinfecting tasks for medical instruments (changing sterilisation solutions and manual disinfection). Furthermore, cleaning and disinfecting tasks for medical instruments were also positively associated asthma symptom score and airway inflammation (FeNO). This finding is consistent with previous studies that have demonstrated an association between agents used for medical instrument cleaning and disinfection (glutaraldehyde, formaldehyde, hydrogen peroxide, quaternary ammonium compounds and enzymatic cleaners) and asthma or rhinitis (7–10). Arif *et al* (8) reported significantly increased odds of reported asthma among HWs exposed to medical instrument cleaning agents (OR = 1.67; 95% CI: 1.06 to 2.62). Lack of consistent associations between WRAS and cleaning-related exposures could be due to healthy worker survival bias in that HWs who developed symptoms due to cleaning agents may have self-selected themselves out of their jobs, redeployed to other jobs/areas with less exposure or left the workforce completely. In this study, 2% of study participants had to change their jobs due to WRAS. The major agents responsible for the WRAS included the general dust, natural rubber latex and OPA / glutaraldehyde. Healthy worker survival bias has been reported in other studies of HWs exposed to cleaning agents (6,7,16).

Glutaraldehyde was widely used in the past as a high-level disinfectant for medical instruments in health care settings, its use has declined since exposure to glutaraldehyde has been linked to various adverse health effects including ocular-nasal symptoms and asthma (9,10,35–38). Although some health facilities have switched to other high-level disinfectants such as OPA and QACs, glutaraldehyde was still the most common high-level disinfectant used in the Tanzanian hospital compared to the South African hospital that commonly used OPA in the past decade.

Although initially considered a safer replacement for glutaraldehyde, OPA has increasingly been reported to cause occupational asthma, contact dermatitis and anaphylaxis in health workers as well as patients undergoing instrument procedures during this period (39–45). A more recent study (45) reported a case of occupational asthma in a HW caused by OPA that was confirmed by a specific bronchial challenge test (45). In the study by Miyajima *et al.* (46) of Japanese HWs that performed endoscope disinfection with OPA, 16% reported respiratory symptoms and 9% ocular symptoms related to OPA. Similarly, another Japanese study that only investigated HWs exposed to OPA in endoscopy units reported higher prevalence (24%) of OPA-related symptoms (respiratory, ocular, skin symptoms or headache) (47). In the current study, 13% of HWs who used OPA had OPA-related symptoms (ocular-nasal: 11%, skin: 4% or chest: 3%), consistent with results from the two Japanese studies. In contrast to the two Japanese studies, this current study also used more objective measures by conducting quantitative exposure measurements as well as immunological assessment for OPA. In the current study, OPA detectable levels (GM = 0.010 ppm) were higher than the newly proposed ACGIH's TLV-Ceiling Limit of 0.0001 ppm.

The results of this current study are consistent with previous studies that have demonstrated an association between exposure to QACs and asthma or rhinitis, not only in HWs but also in domestic cleaners (3,4,9,10,48). During the period of the present study, reports of anaphylaxis in cancer patients undergoing repeated cystoscopies that were sterilised with OPA prompted a switch to a product containing QACs (alkyl dimethyl benzyl ammonium chloride) for disinfection of urologic instruments in the South African hospital. However, due to concerns regarding its effectiveness in infection prevention and HWs reporting work-related symptoms, the disinfectant containing QACs was replaced by another product containing a mixture of acetic acid, peracetic acid and hydrogen peroxide. In the current study a more than 3-fold increased odds of WRAS was observed for HWs that used hydrogen peroxide for medical instrument disinfection. This is consistent with a previous French study (14) that reported two cases of asthma among HWs that was attributed to a peracetic acid-hydrogen peroxide disinfectant used for high-level disinfection of medical instruments. Furthermore, a recent US study (15) also demonstrated positive association between acute nasal and eye irritation with exposure to a mixture containing hydrogen peroxide and peracetic acid and also to hydrogen peroxide, peracetic acid and acetic acid.

In this study, enzymatic cleaners were used in both hospitals for pre-cleaning of medical instruments to remove gross contaminants before disinfecting them with high-level disinfectants. In recent years, there has been an increase in the use of proteolytic enzymes for medical instrument cleaning in the health care settings (11,12). Subsequently, few studies have reported cases of occupational asthma and rhinitis among HWs using enzymatic cleaners (12,13). Immunological assessment of sensitisation to proteolytic enzymes among HWs has proved to be a challenge mainly due to the lack of specific information from manufacturers and suppliers regarding the types of enzymes present in the cleaning products (12). Furthermore, commercially available immunological tests have failed to identify specific IgE antibodies to these enzymes in symptomatic HWs probably due to the lack of specificity of the tests as they were developed for an earlier generation of enzymes, which are thought to have a slightly different molecular structure compared to the newer generation (12). Exposure to proteolytic enzymes is a recognised cause of allergic respiratory and skin symptoms in other occupational groups, particularly among detergent manufacturing workers (11,12).

The findings of this study demonstrated widespread use of chlorine-based bleach that was used commonly for fixed surface cleaning and disinfection but also for medical instrument cleaning and disinfection in both hospitals. After adjusting for known confounders, chlorine-based bleach was positively associated with both asthma symptom score (MR = 1.52; 95% CI: 1.04 – 2.22) and WRONS (OR = 2.50; 95% CI: 1.41 – 4.43). These results are consistent with previous studies that have demonstrated an association between exposure to bleach and asthma-related outcomes (4–7,10,17). In a cross-sectional analysis of a population-based European cohort, domestic use of hypochlorite bleach was associated with lower rates of atopy, hay fever and allergic symptoms but higher rates of lower respiratory symptoms and NSBH (49). The lack of association between bleach and eosinophilic airway inflammation (FeNO) could be due to the irritant nature of bleach-related pathophysiological changes. However, the lack of association between bleach and NSBH could be due to the lack of statistical power due to the small number of participants who performed interpretable methacholine challenge test. Similarly, more symptomatic HWs (≥ 2 asthma-related symptoms) had a two-fold increased odds of using ammonia-based products for fixed surfaces cleaning and disinfection. Previous studies have also reported an association between exposure to cleaning products containing ammonia and asthma-related outcomes (5,6,16,50,51). As in the health setting, both chlorine and ammonia are known to be associated with irritant induced asthma in other occupational settings (4,6,16).

In this study, predominant use of sprays rather than wipes for fixed surface cleaning/disinfection was associated with a 3-fold higher odds of increasing asthma symptom score. This relationship was more pronounced for more symptomatic HWs as evidenced by the 5-fold increased odds of reporting 2 or more asthma-associated symptoms among those who used more sprays than wipes. It is well known that the use of sprays generates more aerosols and hence facilitates inhalational exposure. The results of the current study are therefore consistent with other studies that have demonstrated a positive association between use of cleaning sprays and asthma (and other respiratory symptoms) (7,20,32,50–53). Non-specific bronchial hyperresponsiveness (higher DRS) and FeNO were also positively associated with terminal cleaning of patient rooms and spraying of deodorants/disinfectants respectively. Previous studies have also demonstrated similar associations between fixed surfaces cleaning and asthma (4,8,11,16).

Increased odds of high FeNO were consistently observed among HWs that performed patient care activities in this study. In addition, consistent positive dose-response relationships were observed between specific asthma-related outcomes (FeNO and presence of ≥ 2 asthma-associated symptoms) and either disinfection of patients' skin before procedures or cleaning/disinfection of wounds. These results are consistent with a previous study by Delclos et al, which also demonstrated an association between bronchial hyperresponsiveness–related symptoms and the use of adhesives on patients (11). The products used for patient care activities are mostly irritants (such as alcohols, ethers and acetone), but some such as chlorhexidine are also known sensitisers (11,21,22,54,55).

The present study also demonstrated a positive association between use of formalin solution and increasing FeNO and asthma symptom score in keeping with the findings of previous studies (6,7,56). Formaldehyde is known asthmagen with both irritant and sensitising properties (57,58). Formalin (10%) solution was commonly used in both hospitals for specimen preparation (tissue fixation). The exposure assessment study conducted in the South African hospital identified detectable levels of formaldehyde (GM = 0.005 ppm) in a greater proportion (38%) of the 269 collected samples (Chapter 4). Three (1%) samples had formaldehyde levels higher than the NIOSH recommended exposure limit (REL) of 0.016 ppm TWA, but none greater than the ACGIH TLV-TWA (0.1 ppm).

One of the overall findings of this study showed that FeNO, a non-invasive marker of eosinophilic airway inflammation, was positively associated with the use of OPA, QACs, enzymatic cleaners, chlorhexidine, formalin solution and spraying of deodorants/disinfectants. All of these agents are known sensitisers capable of causing allergic respiratory and skin symptoms in exposed individuals. Deodorants usually contain limonene and pinene, which have both sensitizing and irritant properties and known to be associated with adverse respiratory health effects (1,16,20). Increased FeNO was also commonly observed among HWs who performed patient care activities. This may be due to exposure to sensitising agents such as chlorhexidine commonly used in patient care activities. Alternatively, this could be due to exposure to irritants such as alcohols and ethers used in these tasks. There have been few studies that have reported high FeNO levels in individuals exposed to irritants (59,60), although this is not a common finding. Since irritant exposures are known to enhance allergic inflammation (4,3), increased FeNO levels could also be explained by co-exposure to irritants and sensitisers during the course of their work. This is suggested by the findings of a Spanish study (61) that demonstrated an association between FeNO and usage of multi-use cleaning products, glass cleaners and polishes among professional cleaners.

In a study of this nature, the impact of potential biases need to be considered. There is a possibility of recall bias since self-reported information of chemical usage by HWs in relation to asthma symptoms was used in the study. However, this is unlikely to have had a major influence on the results since consistent associations were also observed with more objective tests such as FeNO. The inability to demonstrate statistically significant associations between NSBH (particularly the categorical variable) and some cleaning agents and tasks could be attributable to the lack of statistical power due to the small number of participants using certain agents. In addition, due to the small number of study participants in the last category (≥100 minutes per week) for some cleaning agents and tasks and some missing information for the duration and frequency data, the results of this study should be interpreted with caution due to the unstable nature of some of these estimates. Since multiple statistical tests were used in this study to investigate the associations between a number of chemicals, spurious associations could have been observed so the results should be interpreted in conjunction with the relevant contextual information. This could also be a possible reason for the inverse association observed between adhesive removing solvents and work-related asthma symptoms, although selection effects in the form of the healthy worker effect may have played a role since symptomatic individuals may choose alternative tasks or jobs associated with less continuous irritant exposures. Furthermore, due to the cross-sectional nature of this study, temporal relationships between exposure to these cleaning agents and asthma-related outcomes could not be determined with certainty. Finally, the lack of objective exposure data also hampered the ability to move beyond duration and frequency of use to more specific exposure metrics such as exposure concentrations to further quantify the dose response relationships.

7.5. CONCLUSION

A number of medical instrument cleaning agents (including OPA, QACs and enzymatic cleaners) and tasks (pre-cleaning of medical instruments, changing sterilisation solutions and manual disinfection of medical instruments) as well as patient care activities were associated with an increased risk of having asthma-related outcomes in health workers of two tertiary hospitals located in sub-Saharan Africa. Furthermore, a positive dose-response relationship was found between work-related ocular-nasal symptoms and medical instrument cleaning agents and tasks. Asthma symptom score was also positively associated with the use of sprays for fixed surface cleaning, confirming the findings of studies in other professional cleaning contexts.

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CHAPTER 8

Summary of study findings, recommendations and conclusion

8.1. SUMMARY OF STUDY FINDINGS

This study was initiated as a result of an increasing trend of work-related asthma (WRA) associated with cleaning agents among health workers (HWs) being referred to the Occupational Medicine Clinic at Groote Schuur Hospital. The thesis examines the magnitude and risk factors for WRA in HWs exposed to cleaning agents in two academic tertiary public hospitals, one in South Africa and the other in Tanzania. It has demonstrated that asthma and work-related symptoms are common in these HWs and that cleaning agents have replaced natural rubber latex (NRL) as an important cause of WRA in health care settings in southern Africa. The novel contribution is in the exposure assessment to cleaning agents using quantitative environmental sampling, immunological assessment of sensitisation to ortho-phthlaldehyde (a high-level disinfectant for medical instrument) and chlorhexidine (used for patient care activities and hand hygiene), and using markers of allergic airway inflammation (FeNO) and bronchial hyperresponsiveness. It further describes various asthma phenotypes in these HWs and investigates host and environmental risk factors associated with work-related asthma outcomes.

8.1.1. CHARACTERISATION OF EXPOSURE TO CLEANING AGENTS AND DETERMINANTS

Most studies investigating the relationship between cleaning agents and asthma have lacked systematic exposure assessment, with only a few reports of quantitative measurements in the health setting (1,2). This is largely due to the challenges associated with exposure assessment of cleaning agents, since many cleaning agents are usually used simultaneously resulting in complex airborne exposures that require multiple sampling techniques (3). The current study has addressed some of these challenges by conducting detailed exposure assessment through environmental measurements of aldehydes (ortho-phthalaldehyde - OPA, glutaraldehyde and formaldehyde) and biomonitoring for exposure to chlorhexidine. The current study has demonstrated that a wide variety of agents are used for cleaning and disinfection in hospital settings located in southern Africa (**Chapter 4**). Although, cleaning agents used in this study were similar to those used in other health care settings, the frequency and duration of use differed from these contexts.

The most common high-level disinfectant used in the South African hospital (SAH) was OPA followed by hydrogen peroxide. However, in the Tanzanian hospital (TAH), glutaraldehyde was more commonly used, followed by OPA. Products that are used for cleaning medical instruments prior to disinfection such as enzymatic cleaners and chlorine-based bleach products were used for the longest duration compared to the high-level disinfectants. For fixed surfaces cleaning and disinfection, chlorine-based bleach was the most common product, which also had the longest average duration of use in both hospitals. In the SAH, HWs used both the hypochlorite liquid bleach and the granules (which were dissolved in water before use). Hypochlorite liquid bleach and troclosene sodium effervescent tablets were used in the TAH.

While floor finishing tasks were not performed by HWs in the TAH, floor strippers and waxes were used once a year in each department in the SAH as well as buff sprays (diluted floor waxes) which were used more frequently. Formalin (10%) solution was commonly used in both hospitals for specimen preparation (tissue fixation), mostly in areas where procedures were performed such as operating theatres. However, HWs in the SAH reported a higher duration of formalin use than their Tanzanian counterparts. Alcohols and povidone iodine were used commonly in both hospitals for disinfection of patients' surfaces before a surgical or instrument procedure or for wound care, with the longest duration of use recorded in emergency units as well as in operating theatres and intensive care units. On the other hand, chlorhexidine containing products were commonly used in the SAH for patients' surfaces disinfection and wound care but not in Tanzania. Liquid products for hand hygiene were used quite commonly by HWs in all the departments studied in both hospitals although SAHWs reported much higher frequency of use. Chlorhexidine containing products, liquid hand soap and alcohol sanitisers were the most common hand hygiene products used in the SAH while in the TAH, a diluted all-purpose cleaner was the most commonly used, followed by an alcohol sanitiser.

In this study, OPA was detectable in 6 (2%) of all samples analysed. These detectable samples (GM = 0.010 ppm) were all collected in the gastrointestinal unit of the SAH and all had OPA levels higher than the newly proposed ACGIH's TLV-Ceiling Limit of 0.0001 ppm (4). Furthermore, OPA levels were, on average, 10-fold higher than in similar settings elsewhere and were dependent on the type of department, job title, personal use of OPA and duration of use. Formaldehyde, on the other hand was detectable in a greater proportion (38%) of the 269 collected samples (GM = 0.005 ppm), with three (1%) samples recording formaldehyde levels higher than the NIOSH recommended exposure limit (REL) of 0.016 ppm TWA, but none greater than the ACGIH TLV-TWA (0.1 ppm). Formaldehyde levels recorded in the current study were, on average, 10-fold lower compared to studies among laboratory workers in hospital settings (5). Laboratory workers are well known for their higher usage of formaldehyde for specimen preparation compared to other categories of hospital workers. Furthermore, the formaldehyde levels in the current study were more comparable to average levels in US general buildings (6). Since only a small proportion of the variability in the formaldehyde levels measured in the current study was explained by the type of department, it is probable that the most likely source of exposure is the widespread use of formaldehyde (10%) solution used for specimen preparation in most departments, residue evaporation from formaldehyde contaminated surfaces and other general indoor sources.

While the study was initially set up to determine the concentration of chlorhexidine and its metabolites (*p*-chloroaniline (PCA) and 1-chloro-4-nitrobenzene), the development of an assay only for PCA proved feasible. PCA was detectable in 13 (4%) of all 336 urine samples that were analysed (GM = 2.41 ng/ml), which did not appear to differ by department or job type. It was not possible to compare the measured PCA levels in this study with other studies due to the lack of exposure measurements obtained using standardised, validated and sensitive methods for chlorhexidine. Nevertheless, the findings of this study could be a useful comparison for future studies focussing on measuring PCA in urine.

The study also highlighted that workplace controls for reducing exposure to cleaning agents were inadequate. Notably, there were no local exhaust ventilation (LEV) systems in any of the work areas evaluated. Whilst extractor fans were present in a few areas, their effectiveness/efficiency was not assessed. Furthermore, use of appropriate personal protective equipment was very low and none of the workers used appropriate respirators nor was appropriate protective clothing made available to prevent dermal exposure. Moreover, a low proportion of HWs (44% in SAH and 23% in TAH) had received training on adverse health effects caused by cleaning agents, while none had undergone medical surveillance.

8.1.2. PREVALENCE OF SYMPTOMS, ALLERGIC SENSITISATION AND LUNG FUNCTION ABNORMALITIES

The findings of this study have demonstrated that HWs in the two tertiary academic hospitals experienced an appreciable proportion of work-related airway and skin symptoms similar to their counterparts in other regions of the world. As has been reported in most studies of work-related rhinitis and asthma (7), the prevalence of work-related ocular-nasal symptoms (WRONS) was twice as common as asthma symptoms in this study. Furthermore, in this current study, the prevalence of WRONS (23%) and asthma symptoms (12%) was higher than that reported in South African dental HWs (14% and 4% respectively) (8) (**Chapter 5**). Moreover, in this current study, the prevalence of work-related asthma symptoms (WRAS) in the past 12 months (7%) was higher than a US study of HWs (3.3%) and on the upper end of the range compared to a Saudi Arabian study of HWs (5.7%), both of which used a similar definition of WRAS (9,10). This is most likely due to inadequate workplace controls observed in the current study. In addition, 16 (2%) workers with WRAS in the current study had to change their jobs due to these symptoms, underscoring the negative consequences associated with WRA. Unlike upper and lower airway symptoms that were similar across both hospitals studied, a higher prevalence of skin symptoms (work-related and non-work-related) was reported among South African HWs (SAHWs), which is most likely due to the significantly ($p<0.001$) higher frequency of hand washing at work among SAHWs (58 times per day), compared to Tanzanian HWs (20 times per day).

In this study, the prevalence of atopy (positive Phadiatop test) was higher (47%) in the SAHWs compared to the Tanzanian HWs (40%) and on upper end of other workplace-based South African studies (36 – 46%) (8,11–13). Furthermore, in the current study, 8% of HWs had OPA allergic sensitisation or work-related symptoms due to OPA, with HWs experiencing more ocular-nasal symptoms (3%) compared to chest (2%) and skin (1%) symptoms.

Despite 20% of SAHWs reporting work-related symptoms due to chlorhexidine in this study, only three (1%) HWs had evidence of chlorhexidine sensitisation. Since Tanzanian HWs (TAHWs) did not use chlorhexidine containing products, immunological assessment for chlorhexidine was not evaluated in the latter group. The low prevalence of chlorhexidine sensitisation in this study is similar to the findings by Garvey *et al.* that did not identify any HW with sensitisation to chlorhexidine using a different series of immunological skin tests (skin prick, intradermal and patch tests) (14). In contrast, several cases of chlorhexidine allergy have been frequently reported among patients, which may be related to direct mucosal contact during operative procedures (15).

In this current study, the prevalence of NRL sensitisation was 2% compared to a previous study (16) conducted more than a decade ago in the same SAH, which reported a 9% prevalence of NRL sensitisation. The decline in prevalence of NRL sensitisation is most likely related to the latex avoidance measures implemented in the hospital following the initial study, more specifically the substitution of powdered latex gloves with less-powdered/powder-free low protein gloves in accordance with the hospital's latex policy.

In this current study, pulmonary function tests revealed significantly lower lung volumes among TAHWs compared to their South African counterparts. One possible explanation for this finding is the high frequency of repeated childhood chest infections reported in the TAHWs. Repeated childhood chest infections has been reported to be a risk factor for the lower adult FEV_1 (17). Another possible explanation for the observed difference is the exposure to biomass fuel, which is commonly used for cooking by most individuals (99.5%) (18). Furthermore, a higher prevalence of airway obstruction was also found in this group of TAHWs, which could be related to the higher prevalence of repeated childhood chest infections and biomass fuel exposure reported by TAHWs.

The median FeNO levels (17 ppb) obtained for HWs in the current study were comparable to the findings reported in other workplace-based studies in Tanzania and South Africa in non-health care settings (13,19–22). However, the prevalence of high FeNO (>50 ppb) indicative of allergic airway inflammation in the current study (6%), was much lower than previous South African study of workers exposed to predominantly high molecular weight protein agents (11%) (19). This suggests that WRA observed in this current group of workers had both allergic and non-allergic components, that required further investigation (2,23).

8.1.3. ASTHMA PHENOTYPES AND HOST-RELATED RISK FACTORS

In previous studies, the reported prevalence of asthma among HWs has varied quite widely most likely due to the different asthma definitions used. Therefore, the standardized ECRHS definition of current asthma was used in this study. The prevalence of current asthma was 10%, with atopic asthma (6%) more prevalent than non-atopic asthma (4%). Overall, there were 2% of subjects with WRA (**Chapter 6**). In addition, most asthma-related outcomes (DRS, asthma symptom score and current asthma) and work-related outcomes (WRONS, WRAS and work-related asthma) were positively associated with allergic disease attributes (atopy, history of hay fever, family history of allergy and FeNO). In this study, there was also a weak positive association between bronchial hyperresponsiveness and FeNO. These findings suggest different underlying pathophysiological mechanisms that co-exist. However, it would appear that allergic mechanisms may be playing a more dominant role in work-related asthma in these HWs. The pathophysiological mechanisms involved in asthma related to cleaning agents are still not yet clear for most of the cleaning chemicals. Previous studies have suggested involvement of both allergic and irritant mechanisms although the latter has been generally thought to be the dominant mechanism. Furthermore, it is probable that both these mechanisms may enhance each other, such that airway epithelial damage due to irritant exposures can also activate an allergic T helper type 2 (Th2) response and increase the risk of sensitisation (2,23).

In this study, stronger associations were observed for asthma symptoms when FeNO ≥ 50 ppb (a marker of allergic airway inflammation) was combined with NSBH (BDR or MCT positive). Furthermore, stronger associations were also observed between sensitisation to occupational allergens and atopy. With the exception of one non-atopic participant who was sensitised to OPA, all the remaining HWs that were sensitised to occupational allergens (OPA, chlorhexidine and NRL) were atopic. Most studies have reported a greater likelihood of atopic individuals developing sensitisation to high molecular weight occupational allergens (12,13,22,24). The findings of the current study that atopic individuals are also more likely to be sensitised to low molecular weight occupational allergens such as OPA and chlorhexidine, add to the small number of agents in other exposure contexts demonstrating a similar finding. Serum specific IgE antibodies to OPA and chlorhexidine have also been detected in a few studies of individuals exposed to these agents (15,25–27). Furthermore, animal studies have suggested that OPA is a respiratory and dermal sensitiser as was evidenced by a predominant expression of Th2 cytokines (IL-4, IL-5 and IL-13) in mice that were exposed to OPA (28,29). In addition, the clinical history in the case reports of asthma due to OPA also demonstrated a latency period between first exposure to OPA and development of symptoms implying immunologic response caused by OPA (30,31). Interestingly, animal studies have also suggested that OPA is more irritant than GTA using both *in-vitro* EpiDerm Skin Irritation Test and *in-vivo* tests (28). In addition to being consistent with an immunological mechanism, this further suggests that the mechanism is probably IgE-mediated. Future studies should investigate this further so as to have a better understanding of the underlying pathophysiological mechanisms associated with asthma to these agents.

As to be expected, FeNO (a non-invasive marker of eosinophilic airway inflammation) was positively associated with allergic predictors (atopy and history of hay fever) and a history of childhood-onset asthma. Even stronger associations were observed with high FeNO (≥50 ppb) levels. A positive association between FeNO and atopy is well-known and has also been reported in recent South African studies in other occupational exposure contexts (13,19,22), while the few studies that have conducted FeNO studies in Tanzania did not assess the role of atopy (20,21). Furthermore, a strong positive association (OR_{unadj} = 3.59, CI: 1.63 – 7.93; OR_{adj} (atopy + smoking) = 1.93, CI: 0.85 – 4.37) was also observed between elevated FeNO (≥25 ppb) and allergic sensitisation to OPA / chlorhexidine. Much stronger relationships have been demonstrated in workplace-based studies among South African workers exposed to predominantly high molecular weight agents (13,19).

In this current study, a positive association was observed between female gender and asthma-related outcomes consistent with other studies of asthma and occupational exposures to cleaning agents. This could be explained by the gendered distribution of the workforce, since a large proportion (78%) of study participants were women. However, new-onset asthma in adulthood has been shown to be more prevalent amongst women with female sex hormones implicated in the pathogenesis (32).

Interestingly, in the current study, a past history of pulmonary tuberculosis (TB) was strongly associated with asthma-related outcomes. This association persisted even after adjusting for age, gender, smoking, atopy and body mass index. Similar findings have also been reported in South African population-based and workplace-based studies (33,34). This observation needs further exploration in a larger longitudinal study of these HWs.

In this study, smoking was positively associated with only certain asthma-related outcomes (asthma symptom score and with non-atopic asthma). This is consistent with the current body of evidence with studies reporting inconsistent findings of the association between smoking and asthma in general and with occupational asthma in particular (32,35). Furthermore, very limited specific information is available on the risk of smoking in relation to asthma among HWs exposed to cleaning agents (35,36). The study by Zock *et al*. in cleaning workers did not demonstrate any association between smoking and asthma (36). Additional longitudinal studies are needed to better understand this relationship between smoking, occupational allergic sensitisation and asthma risk among HWs exposed to cleaning agents.

8.1.4. EXPOSURE-RESPONSE RELATIONSHIPS

This study has identified a number of cleaning agents and tasks that are positively associated with asthma-related outcomes (asthma symptoms, bronchial hyperresponsiveness and FeNO) and WRONS. This consistent association with multiple asthma parameters suggests overall consistency and confidence in this relationship. Furthermore, there was also some specificity in these relationships in that consistent associations were more prominent for certain medical instrument cleaning agents (OPA, QACs and enzymatic cleaners) and tasks (pre-cleaning of medical instruments, changing sterilisation solutions and manual disinfection of medical instruments) as well as certain patient care activities (disinfecting patients' skin before procedure, cleaning/disinfecting wounds, applying wound dressing, using adhesives and adhesive removing solvents). A particularly pronounced dose-response relationship was observed between WRONS and medical instrument cleaning agents associated with asthma and tasks (**Chapter 7**).

In this study, predominant use of sprays rather than wipes for fixed surface cleaning/disinfection was associated with a 3-fold increased odds of having a higher asthma symptom score. This relationship was more pronounced for more symptomatic HWs as evidenced by the 5-fold increased odds of reporting 2 or more asthma-associated symptoms among those who used more sprays than wipes. It is well known that the use of sprays generates more aerosols and hence facilitates inhalational exposure. The results of the current study are therefore consistent with other studies that have demonstrated a positive association between use of cleaning sprays and asthma (and other respiratory symptoms) (37–43). Non-specific bronchial hyperresponsiveness and FeNO were also positively associated with terminal cleaning of patient rooms and spraying of deodorants/disinfectants respectively, consistent with previous studies that have demonstrated similar associations between fixed surfaces cleaning and asthma (23,44–46).

Increased odds of high FeNO were consistently observed among HWs that performed patient care activities in this study. In addition, consistent positive dose-response relationships were observed between specific asthma-related outcomes (FeNO and presence of ≥ 2 asthma-associated symptoms) and either disinfection of patients' skin before procedures or cleaning/disinfection of wounds. These results are consistent with a previous study by Delclos *et al*., which also demonstrated an association between bronchial hyperresponsiveness–related symptoms and the use of adhesives on patients (45). The products used for patient care activities are mostly irritants (such as alcohols, ethers and acetone), but some such as chlorhexidine are also known sensitisers (45,25,27,47,15).

One of the overall findings of this study showed that FeNO, a non-invasive marker of eosinophilic airway inflammation, was positively associated with the use of OPA, QACs, enzymatic cleaners, chlorhexidine, formalin solution and spraying of deodorants/disinfectants. All of these agents are known sensitisers capable of causing allergic respiratory and skin symptoms in exposed individuals. Deodorants usually contain limonene and pinene, which have both sensitising and irritant properties and known to be associated with adverse respiratory health effects (48,46,38). Increased FeNO was also commonly observed among HWs who performed patient care activities. This may be due to exposure to sensitising agents such as chlorhexidine commonly used in patient care activities. Alternatively, this could be due to exposure to irritants such as alcohols and ethers used in these tasks. There have been few studies that have reported high FeNO levels in individuals exposed to irritants (49,50), although this is not a common finding. Since irritant exposures are known to enhance allergic inflammation (23,2), increased FeNO levels could also be explained by co-exposure to irritants and sensitisers during the course of their work. This is suggested by the findings of a Spanish study (51) that demonstrated an association between FeNO and usage of multi-use cleaning products, glass cleaners and polishes among professional cleaners.

8.2. STRENGTHS AND LIMITATIONS

8.2.1. STRENGTHS

To the knowledge of investigators, this is the first study in Africa to have conducted quantitative exposure assessment for aldehydes (OPA, glutaraldehyde and formaldehyde) in hospital settings. This study is also the first African study to have conducted biological monitoring for evaluation of chlorhexidine exposures in HWs. The study is also unique in that it was conducted in two different southern African hospital settings (SAH and TAH) using similar qualitative and quasi-quantitative exposure assessment methods for exposures to cleaning agents. Notably, the study has described the most common cleaning agents used for specific cleaning tasks in these settings and the typical frequency and durations of exposure to cleaning agents in different hospital departments in two different contexts in southern Africa.

This is also the first study in southern Africa of HWs exposed to cleaning agents and the first globally to have undertaken an extensive epidemiological study, using multiple clinical endpoints of asthma, including the immunological assessment of HWs to OPA and chlorhexidine and assessing the presence of airway inflammation using exhaled nitric oxide. Previous studies reported only on the presence of work-related symptoms and did not provide more objective measures of work-related allergy and asthma as was done in the current study. Furthermore, this is also the first epidemiological study on the immunological assessment of HWs sensitized to NRL in Tanzania.

8.2.2. LIMITATIONS

Selection bias due to healthy worker effect (healthy worker selection bias and healthy worker survival bias) is one of major challenges of workplace-based cross-sectional epidemiological studies. Healthy worker selection bias could have underestimated the effect of cleaning agents on asthma if individuals without respiratory symptoms/disorders such as asthma were more likely to select themselves or be screened into jobs with exposure to cleaning agents in the hospitals. However, since this practice was non-existent in the hospitals studied, this type of selection bias was unlikely to have affected the results of this study. On the other hand, HWs who developed symptoms due to cleaning agents may self-select themselves out of their jobs, redeployed to other jobs/areas with less exposure or leave the workforce completely and hence cause another type of selection bias (healthy worker survival bias). This may have impacted on the overall prevalence of work-related asthma reported in this study. While only 2% of study participants changed their jobs due to WRAS in this study, selection bias may have influenced the direction of the bias towards the null resulting in less power to demonstrate some of the associations. This could have been further compounded by the 53% overall response rate and lack of information on health workers who may have left their job due to their asthma symptoms.

Some of the asthma phenotypes such as current asthma, asthma symptom score and work-related asthma were based on self-reported information from the questionnaire. This could have resulted in misclassification of asthma status. Self-reported symptom information is usually characterised by high sensitivity but low specificity in identifying individuals with asthma. However, in this study, self-reported asthma information correlated relatively well with NSBH and FeNO (**Chapter 6**). Furthermore, there is also a possibility of differential misclassification of the exposure to cleaning agents since self-reported information of chemical usage was used. This would be possible if HWs with asthma symptoms recalled better their use of cleaning products and hence the direction of the bias would be away from the null. However, this bias is unlikely to have had major influence on the results since consistent associations were also observed with objective tests such as FeNO (**Chapter 7**).

In the current study, there were some limitations in obtaining a comprehensive immunological evaluation of the Tanzanian group. Immunological assessment of sensitisation to glutaraldehyde was not done due to the lack of commercially available immunoCAP for glutaraldehyde. This is important since glutaraldehyde continues to be used as a high-level disinfectant in the TAH. Similarly, it was not possible to conduct immunological assessment of sensitisation to enzymatic cleaners in this study due to the lack of specific information from manufacturers and suppliers regarding the types of enzymes present in the cleaning products. Furthermore, commercially available immunological tests have failed to identify specific IgE antibodies to these enzymes in symptomatic HWs probably due to the lack of specificity of the tests as they were developed for an earlier generation of enzymes, which are thought to have a slightly different molecular structure compared to the newer generation. Additionally, methacholine challenge tests could not be conducted in the TAH due to logistical reasons. Hence, a slightly less composite picture of HWs in this hospital was obtained compared to their South African counterparts. Nevertheless, the study has provided important insights into work-related asthma in southern African HWs exposed to OPA and NRL.

The inability to demonstrate statistically significant associations between NSBH (particularly the categorical variable) and some cleaning agents and tasks could be attributable to the lack of statistical power due to the small number of participants using certain agents. Moreover, the lack of objective exposure data (e.g. only 2% of the samples analysed had detectable OPA levels) also hampered the ability to move beyond duration and frequency of use to more specific exposure metrics such as exposure concentrations to further quantify the dose response relationships.

The study initially sought to determine quantitative exposure to chlorhexidine and its metabolites (PCA and 1-chloro-4-nitrobenzene) in urine. Due to logistical and methodological considerations, it was not possible to develop a multiplex assay for all these compounds except for PCA. Furthermore, although a robust assay for PCA was developed in the current study, it was not possible to compare with other studies because of lack of information in the literature. In this study, passive sampling was used for environmental exposure assessment of aldehydes. While environmental conditions such as temperature, relative humidity, ozone and air movements are well known factors that could affect the performance of passive samplers in measuring airborne aldehyde concentrations, these factors are less likely to have affected the study findings since most workers worked indoors, with insignificant air movements and temperatures that ranged between 22 to 30 degrees Celsius and relative humidity ranging between 40 – 68%. While ozone measurements have also been conducted in some studies, there were not done due to resource constraints.

While the results of this study may be generalisable to tertiary and secondary level hospitals in Southern Africa, they may not be relevant to primary health care settings where some of cleaning-related tasks are not performed and certain chemicals are not used.

8.3. RECOMMENDATIONS

8.3.1. An oversight committee of occupational health and infection prevention personnel

In recent years, infection prevention and control (IPC) in health care settings has become increasingly important due to the risk of healthcare associated infections, particularly those caused by multi-drug resistant organisms. However, these efforts need to be balanced with the protection of HWs from harmful exposure to a wide variety of cleaning agents that are used for IPC. The best way to accomplish this is to establish a team of both IPC and occupational health and safety (OHS) professionals to steward both considerations in order to achieve optimal outcomes.

One of the impacts of this study has been the establishment of a working group of OHS and IPC staff as well as other stakeholders (e.g. procurement of chemicals) at the SAH that regularly reviews new cleaning agents to be introduced into various departments in the hospital. The working group assesses the new cleaning agents with regard to their effectiveness in IPC as well as the potential adverse health effects to HWs. The establishment of the group was proposed as a result of regular meetings between the study investigators and various stakeholders in the SAH during the planning and fieldwork periods. At the time, it was not possible to have the same working group at the TAH as there were no OHS services provided for the hospital workers. However, the study investigators will recommend the development of an OHS service to the TAH management and also assist them in establishing this oversight committee involving IPC, OHS and other stakeholders (e.g. procurement of chemicals, waste disposal). The aim is to have an integrated approach towards prevention of both work-related diseases and healthcare associated infections in the hospital. This approach has also been recently proposed by a multidisciplinary group in the US (52). Apart from identifying the least hazardous cleaning agents for use in the hospital, the committee should also be responsible for assessment of the ongoing cleaning activities and recommend the best work practices to be pursued during cleaning and disinfection as well as other appropriate exposure control measures. This committee should also be responsible for assessing the compliance of staff to the proposed work practices and address any other issues related to IPC and the management of workers experiencing adverse health effects due to cleaning agents.

8.3.2. Workplace control measures

Elimination and Substitution

Substitution of hazardous agents with less hazardous or non-hazardous agents is usually the preferred method of prevention for work-related diseases since it is a more effective approach than other methods. In the current study, some of the cleaning agents such as OPA, QACs and enzymatic cleaners were consistently identified to be associated with asthma and skin symptoms. Furthermore, during the period of the present study, reports of anaphylaxis in cancer patients undergoing repeated cystoscopies that were sterilised with OPA prompted a switch to a product containing QACs (alkyl dimethyl benzyl ammonium chloride) for disinfection of urologic instruments in the SAH. However, due to concerns regarding its effectiveness in IPC and work-related symptoms among exposed HWs, the disinfectant containing QACs was replaced by another product containing a mixture of acetic acid, peracetic acid and hydrogen peroxide. While glutaraldehyde had already been replaced with OPA at the SAH a few years prior to the commencement of the study, it continued to be used at the TAH. However, the current study findings have now also confirmed an association between exposure to OPA and adverse health outcomes, consistent with other studies recently being reported. Substituting OPA also pose a challenge since other alternatives such as hydrogen peroxide or a mixture of acetic acid, peracetic acid and hydrogen peroxide have also been recently reported to produce adverse health effects. Similar challenges exist regarding substitution of enzymatic cleaners, more so since exact enzymes that are being used in these products are being withheld from producers of these agents. When considering substitution, care should be exercised not to replace an agent with known hazards with an agent that has similar potential, as was seen when glutaraldehyde was replaced by OPA. Quantitative structure-activity software that can predict sensitisation potential of chemicals may be very useful for decisions regarding new cleaning agents to be introduced in the workplaces (53–55). The use of “green” cleaning agents is promising but more studies are needed regarding their potential health effects to workers and patients as well as their effectiveness in IPC (56). Moreover, there are no universally accepted criteria for green cleaners and there may be some challenges in accessing these cleaning agents in resource constrained health care settings. As a result of these challenges associated with substitution, other control measures such as engineering methods and administrative controls should also be considered in an effort towards prevention of WRA associated with cleaning agents in the health care setting.

Engineering controls

In the study, medical instrument cleaning and disinfection tasks (e.g. pre-cleaning of medical instruments, changing sterilisation solutions and manual disinfection of medical instruments) were consistently associated with work-related asthma outcomes. These tasks are usually performed in certain dedicated areas enabling the use of engineering control methods such as local exhaust ventilation (LEV) systems. The areas where these tasks are performed in both hospitals should have LEV systems located at the source of exposure, which should undergo regular preventive maintenance. A recent study (57) has proposed specific ventilation standards for areas where OPA is used for high-level disinfection of medical instruments. Since detectable OPA levels were all higher than the newly proposed ACGIH's TLV-Ceiling Limit of 0.0001 ppm, engineering controls should be seriously considered in these hospitals. In addition, further occupational hygiene monitoring need be conducted in order to evaluate the effectiveness of the implemented exposure control measures. In addition, general ventilation should be improved in all hospital areas so as to reduce exposure of HWs to ubiquitous cleaning agents such as those used for fixed surfaces cleaning.

Administrative controls

There should be written policies and codes of practise for the use of different cleaning agents for various cleaning tasks in the hospital. Several administrative controls should be considered in the light of the specific findings of this study. Since a higher asthma symptom score was observed in HWs that used sprays more frequently than wipes, the use of sprays should be replaced with wipes where possible. Entry into certain dedicated areas such as those used for medical instrument cleaning and disinfection should be restricted to properly trained workers. Health workers should be trained in the proper use, storage and disposal of cleaning agents; use of appropriate personal protective equipment (PPE) and potential health effects associated with exposure to cleaning agents. In this study, a low proportion of HWs (44% in South Africa and 23% in Tanzania) had received training on adverse health effects due to cleaning agents. Mixing of different cleaning products (such as bleach and ammonia) should be avoided. There should also be regular supervision and monitoring of cleaning-related work practices among workers.

Personal protective equipment (PPE)

Use of PPE is the least effective method for the control of exposure to work-related hazards. Since inadequate engineering and administrative methods were demonstrated in both hospitals, in the interim, HWs should use appropriate PPE until more effective control measures are in place. For most cleaning tasks, HWs should use appropriate gloves, fluid repellent clothing (gowns/aprons) and protective shoes. For certain tasks such as those involved in medical instrument cleaning and disinfection, proper eye protection (e.g. goggles / face shields) and respirators with vapour cartridges should be used in addition to gloves, fluid repellent clothing and shoes. Hospital management should provide PPE to HWs after appropriate consultation with workers in order to ensure the most appropriate PPE is chosen and achieve worker compliance as to their use.

8.3.3. Medical surveillance programmes

Secondary prevention through instituting appropriate medical surveillance programmes is advised for HWs exposed to cleaning agents. This will enable identification of affected HWs relatively early in their employment and inform redeployment strategies and removal from further exposure of affected workers in order to reduce progression and disability due to occupational asthma. Medical surveillance, together with occupational hygiene surveillance will also be useful to determine effectiveness of the workplace control measures that are implemented in the hospital. There should be pre-placement as well as annual periodic medical assessment of these workers, preferably using a symptom questionnaire. More frequent surveillance (e.g. every 6 months) is recommended in the first two years of employment due to increased risk in those exposed to respiratory sensitisers. Further testing (e.g. spirometry) can be done to HWs with suspected work-related upper and/or lower airway symptoms associated with exposure to respiratory sensitisers/irritants. For HWs exposed to known sensitisers such as OPA, immunological assessment through detection of specific IgE to OPA could be useful, if commercially available, in those health workers that report work-related symptoms.

8.3.4. Future research

Most of the cleaning agents that have been reported in literature do not have specific regulatory exposure standards or need to be reviewed in the light of new evidence. Improved dose-response studies using quantitative exposure assessment strategies are needed in order to develop regulatory exposure standards for these cleaning agents and to assess whether the current exposure standards are protective. More reliable and valid data can be obtained through a combination of methods including self-reported information from questionnaires, job-exposure matrices, expert judgments and quantitative measurements. There is a need for more studies on the exposure characterisation using biomonitoring approaches to chlorhexidine and its metabolites (PCA and 1-chloro-4-nitrobenzene) in biological fluids, with particular efforts towards the development of standardized, sensitive and validated assays for this agent due to its widespread use in most settings. Future studies in this group should also explore the possibility of conducting both skin prick tests and specific IgE to common sensitisers (e.g. enzymatic cleaners and glutaraldehyde) in order to obtain a more comprehensive immunological assessment of symptomatic workers. Furthermore, the current study findings need to be replicated in future studies among HWs exposed to cleaning agents. There is a need for larger prospective studies in HWs exposed to cleaning agents using various clinical, physiological and inflammatory markers including sputum eosinophils and serum periostin in order to further characterise the asthma phenotypes in HWs exposed cleaning agents. This will inform improved clinical management and preventive strategies for these HWs. More studies are needed to study health effects of “green” cleaning agents that are increasingly been proposed and newly introduced into the health care setting.

8.4. CONCLUSION

This study has demonstrated that detectable exposures to OPA are higher and more isolated to certain departments than the more widespread low-level formaldehyde exposures present throughout the hospitals. Furthermore, cleaning agents have replaced NRL as important causes for WRA in health settings. Finally, specific cleaning agents such as OPA, quaternary ammonium compounds and enzymatic cleaners associated with medical instrument cleaning/disinfection as well as patient care activities and the use of sprays for fixed surface cleaning are important environmental risk factors, for various asthma-related outcomes among HWs in health care settings.

8.5. REFERENCES

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RISK FACTORS FOR WORK-RELATED ASTHMA IN HEALTH CARE WORKERS WITH EXPOSURE TO DIVERSE CLEANING AGENTS – 2014 HREC REF: 212/2013

CONSENT FORM

1. **Title of research project**

   Risk factors for work-related asthma in health care workers with exposure to diverse cleaning agents in two African health care settings – Groote Schuur Hospital and Muhimbili National Hospital

2. **Purpose of the research**

   The University of Cape Town is conducting this important study of work related asthma in health care workers. This study is going to be done by researchers who are independent of the hospital. We will be studying health care workers working in the different departments of the hospital. It is hoped that this study will provide greater insight into the risk factors for work related asthma among health care workers and identify appropriate preventative strategies to be implemented in order to reduce the incidence of asthma among health care workers.

3. **Description of the research project**

   If you agree to participate you will be asked to complete the following tests during working time:

   a) **Complete a questionnaire**. A member of our study team will interview you in privacy to complete the questionnaire. You will be asked questions about any breathing or chest problems; current and previous employment history; and working with different products at the hospital.

   b) **Blood test**
   You will also be asked to undergo a blood test to check for allergies to specific allergens. Ten ml (about two teaspoons) of blood will be drawn once by a nurse.

   c) **Breathing tests**
   - You will be asked to blow several times into a machine which measures how well your lungs are working.
   - You will be asked to repeat the breathing test after you first breathe in a small amount of a chemical substance (methacholine). Methacholine is a chemical that can cause the airways to become narrow. This test helps us to find out if you may have a breathing problem like asthma. You may be asked to breathe in this substance and then blow into the machine several times.
   This test will not be done if you are pregnant or breastfeeding.
   - You will also be asked to blow two times into a NIOX MINO machine, which measures nitric oxide produced by the airways. This machine is used to detect if a person has allergic airway inflammation which is present in asthma or rhinitis.

   d) **Urine test**
   - We will collect a urine sample to test for chlorhexidine and its products.
   - Should you be uncertain of your menstrual pattern you will be offered a urine pregnancy test before we conduct the breathing test with methacholine.

4. **Confidentiality of information collected**

   Your name will not appear on any reports or data collection forms. The records of blood tests, questionnaires and breathing tests will be kept completely confidential and will be seen only by members of the study team.

5. **Risks and discomforts of the research**

a) **From the questionnaire:** Some of the research questions may make you uncomfortable; however, we have trained our interviewer to be as sensitive when asking these questions. You may be concerned about confidentiality of the information that you provide; however, we have taken precautions to minimize this risk.

b) **From the blood tests**. You will feel a single needle stick when the blood is taken. Sometimes a small bruise may occur from the needle stick. The total amount of blood taken is quite small and your body will quickly replace it.

c) **From breathing tests:** There is a small chance that the initial breathing test could cause you to become light-headed or faint. Having you complete the test in a seated position under the observation of trained personnel greatly reduces the chance of your having such a problem. You will be given medicine (salbutamol) to breathe in that works to open your lungs. Although very rare, this medication can briefly cause a fast heartbeat, tremor, nervousness or chest pain. Part of the breathing test uses a chemical substance (methacholine) that can cause headache, cough, shortness of breath, chest tightness, wheezing, hoarse voice or a sore throat for a short time in some people. Very rarely it can cause severe breathing problems. Such breathing problems almost always can be treated successfully immediately with a different medication (salbutamol), which you breathe in. You will only be given the chemical substance (methacholine) if your simple breathing test is normal. This greatly reduces the chance of having a serious problem. These tests will be carried out in a lung function laboratory with medical personnel knowledgeable in the treatment of such problems being immediately available. In a very rare instance the test resulted in a fatality (the individual had a number of methacholine challenge tests over a period of 2 weeks). You will have this test only once.

6. **Expected benefits to you and to others**

You may not receive any personal or direct benefit from participating in this research study. However, you will be given a written copy of all your test results along with an explanation of what they mean, unless you tell us that you do not wish to receive this. You may wish to show these to your doctor if you are having any problems. These tests will help determine if you have asthma or allergy to several substances used in the allergy test. What we learn from this study will help to protect you, and those working with different products in the hospitals in South Africa and other parts of the world. We will learn how best to monitor workers' health and how to reduce workers' exposure to different products.

7. **Costs to you resulting from participation in the study**

The study is offered at no cost to you. In the event a problem is discovered and you wish to be seen by a doctor for it, we can recommend to you who to see. However, the study cannot pay for these additional medical visits or treatments.

8. **Contact person**

You may contact one of the following persons for answers to further questions about the research, your rights, or any injury you may feel is related to the study.

University of Cape Town Researchers:
Prof. Mohamed Jeebhay, Telephone No. (021) 406-6309
Dr Hussein Mwanga, Telephone No. 079 034 1280 / 084 331 2222 / 021 404 5428

University of Cape Town Human Research Ethics Committee (HREC):
Prof. Marc Blockman (021) 406-6492

University of Michigan Medical School Institutional Review Board (IRBMED)
Telephone No. 001-734-763-4768; E-mail: irbmed@umich.edu
2800 Plymouth Road, Building 520, Room 3214, Ann Arbor, Michigan 48105 (USA)

RISK FACTORS FOR WORK-RELATED ASTHMA IN HEALTH CARE WORKERS WITH EXPOSURE TO DIVERSE CLEANING AGENTS – 2014
HREC REF: 212/2013

CONSENT FORM

STUDY NO. ______________

9. **Consent of the participant**

I have read the information given above, or it has been read to me. I understand the meaning of this information, Dr./Mr./Ms. ____
has offered to answer any questions concerning the study. By signing this form, I hereby consent to participate in the study. I also understand that I am free to withdraw from the study at any time without penalty.

10. **Documentation of the consent**

One copy of this signed document will be kept together with our research records for this study. A copy of the information sheet about the study will be given to you to keep.

________________________________ ____________________________
Printed name of participant Signature, Mark, or Thumb Print

_____________________________ __________________________
Interviewer's name (Print) Signature

DATE: __________________

SABABU ZINAZOHUSIANA NA UGONJWA WA PUMU UNAOHUSIANA NA KAZI KWA WATUMISHI WA AFYA WAFANYAO KAZI NA KEMIKALI MBALIMBALI ZA KUFANYIA USAFI KATIKA SEKTA YA AFYA YA NCHI MBILI ZA AFRICA – 2017

FOMU YA RIDHAA

1. **Jina la mradi wa utafiti**

Sababu zinazohusiana na ugonjwa wa pumu unaohusiana na kazi kwa watumishi wa afya wafanyao kazi na kemikali mbalimbali za kufanyia usafi katika sekta ya afya ya nchi mbili za Africa – Hospitali ya Taifa Muhimbili na Hospitali ya Groote Schuur.

2. **Madhumuni ya utafiti**

Chuo kikuu cha afya na sayansi shirikishi Muhimbili (MUHAS) kinafanya utafiti huu muhimu wa ugonjwa wa pumu unaohusiana na kazi kwa watumishi wa afya. Utafiti huu utafanywa na watafiti ambao hawako chini ya utawala wa hospitali ya taifa ya Muhimbili (MNH). Tutafanya utafiti huu kwa watumishi wa afya katika idara tofauti za MNH. Ni matumaini yetu kwamba utafiti huu utatoa ufahamu zaidi kuhusu sababu zinazohusiana na ugonjwa wa pumu kwa watumishi ya afya ili kuweza kupanga mikakati ya kupunguza kasi ya kupata ugonjwa wa pumu kwa watumishi wa afya.

3. **Maelezo kuhusu utafiti**

Kama ukikubali kushiriki katika utafiti huu, utaombwa kufanya mambo yafuatayo wakati wa muda wako wa kazi:

a) **Kujaza dodoso**.
Mmoja wa watafiti wetu atafanya mahojiano na wewe katika sehemu ya faragha. Utaulizwa maswali kuhusu matatizo yoyote ya kupumua au ya kifua; ajira yako ya sasa na ya zamani; na maswali kuhusu kufanya kwako kazi na kemikali mbalimbali katika hospitali hii.

b) **Kipimo cha damu**.
Utaombwa kufanya kipimo cha damu kupima kama una “allergy” na vitu fulani. Muuguzi atatoa mililita 10 (kama vijiko viwili vidogo vya chai) za damu kutoka kwenye mwili wako.

c) **Vipimo vya upumuaji.**
- Utaombwa kupuliza mara kadhaa kwenye mashine ambayo inapima jinsi gani mapafu yako yanafanya kazi.
- Utaombwa vilevile kupuliza mara mbili kwenye mashine ya NIOX MINO ambayo inapima gesi ya nitric oxide inayotolewa na njia ya hewa. Hii mashine inatumika kupima kama mtu ana mabadiliko yatokanayo na “”allergy” kwenye njia yake ya hewa, ambayo huwepo kwa watu wenye ugonjwa wa pumu na “allergy” za pua.

4. **Usiri wa taarifa zinazokusanywa**

Jina lako halitaonekana kwenye ripoti zozote au fomu za kukusanyia taarifa za utafiti huu. Kumbukumbu za majibu ya vipimo vya damu, dodoso na vipimo vya kupumua zitatunzwa kwa usiri wa hali ya juu na ni watafiti tu watakaoweza kuziona.

5. **Madhara na usumbufu wa utafiti**

a) **Kutokana na kipimo cha damu**: Utahisi kuchomwa na sindano mara moja wakati damu yako ikitolewa. Mara nyingine damu inaweza kuvilia kidogo kwenye ngozi kwasababu ya sindano hiyo. Jumla ya kiwango cha damu kinachotolewa ni kidogo sana, mwili wako utatengeza damu kurudisha hiyo iliyotelewa haraka.

b) **Kutokana na dodoso**: Unaweza usifurahie baadhi ya maswali utakayoulizwa, hivyo basi, tumemfundisha mtafiti atakaekuhoji kuwa makini wakati wa kuuliza maswali hayo. Unaweza kuwa na wasiwasi kuhusu usiri wa taarifa unazotupa, hivyo basi, tumechukua tahadhari za kutosha kuepukana na hili.

c) **Kutokana na vipimo vya upumuaji**: Kuna uwezekano japo kidogo wa kupata kizunguzungu au kuzirai. Kufanya kwako vipimo hivi ukiwa umekaa kitako, chini ya uangalizi wa wataalam itapunguza sana uwezekano wa kupata tatizo hilo. Utapewa dawa (salbutamol) ambayo utaivuta ambayo inasaidia kufungua mapafu yako. Ingawa ni nadra sana, dawa hii inaweza kusababisha kwa muda mfupi mapigo ya moyo kwenda mbio, kutetemeka, wasiwasi au maumivu ya kifua. Vipimo hivi vitafanywa katika maabara ya kupima ufanyajikazi wa mapafu na wataalam wa afya wenye ujuzi wa kutibu matatizo hayo watakuwa wanapatikana mara moja.

6. **Faida utakazopata wewe na wengineo**

Unaweza usipate faida yoyote binafsi au ya moja kwa moja kwako kwa kushiriki katika utafiti huu. Hata hivyo, utapewa nakala ya majibu yako ya vipimo pamoja na maelezo yake, au la utuambie hupendelei hivyo. Unaweza kumuonyesha daktari wako hayo majibu ya vipimo kama una matatizo yoyote. Vipimo hivi vitasaidia kugundua kama una ugonjwa wa pumu au "allergy" na vitu mbali mbali. Tutakachojifunza kutokana na utafiti huu itasaidia kukulinda wewe na wale wafanyao kazi na kemikali mbali mbali kwenye mahosipitali ya hapa nchini na sehemu nyingine duniani. Tutajifunza namna bora ya kufatilia afya za wafanyakazi na namna ya kupunguza "exposure" ya kemikali mbali mbali kwa wafanyakazi.

7. **Gharama zitokanazo na kushiriki kwenye utafiti**

Unafanyiwa uchunguzi huu bila gharama yoyote kutoka kwako. Kama tatizo likigunduliwa na unahitaji kuonwa na daktari kwa ajili hiyo, tunaweza kupendekeza daktari gani wa kumuona. Hata hivyo, utafiti huu hauwezi kulipia hizo gharama za ziada za kuonwa na daktari au matibabu.

8. **Mawasiliano**

Unaweza kuwasiliana na mmoja wa watu wafuatao kwa majibu ya maswali zaidi kuhusu utafiti huu au haki zako au tatizo lolote unalofikiri limetokana na utafitti huu.

Watafiti wa chuo kikuu cha afya na sayansi shirikishi Muhimbili (MUHAS)
Prof. Ferdinand Mugusi, namba ya simu: +255 784 613 354
Dr Simon Mamuya, namba ya simu: +255 787 721 377
Dr Hussein Mwanga, namba ya simu: +255 673 341 280

Kamati ya maadili ya utafiti ya chuo kikuu cha afya na sayansi shirikishi Muhimbili (MUHAS)
Namba ya simu: +255-022-2152489; E-mail: drp@muhas.ac.tz

Kamati ya maadili ya utafiti ya chuo kikuu cha Cape Town
Namba ya simu. +27 21 406 6492; E-mail: Shuretta.Thomas@uct.ac.za

Kamati ya maadili ya utafiti ya chuo kikuu cha Michigan
Namba ya simu. 001-734-763-4768; E-mail: irbmed@umich.edu
2800 Plymouth Road, Building 520, Room 3214, Ann Arbor, Michigan 48105 (USA)

SABABU ZINAZOHUSIANA NA UGONJWA WA PUMU UNAOHUSIANA NA KAZI KWA WATUMISHI WA AFYA WAFANYAO KAZI NA KEMIKALI MBALIMBALI ZA KUFANYIA USAFI KATIKA SEKTA YA AFYA YA NCHI MBILI ZA AFRICA – 2017

FOMU YA RIDHAA

Namba ya mshiriki. _______________

9. **Ridhaa ya mshiriki**

Nimesoma maelezo yaliyotolewa hapo juu, au nimesomewa. Ninaelewa maana ya maelezo hayo, Dr./Bwana/Bi. ______________________________________ amejitolea kujibu maswali yoyote yanayohusiana na utafiti huu. Kwa kusaini fomu hii, naridhia kushiriki kwenye utafiti huu. Naelewa vile vile kwamba niko huru kujitoa kwenye utafiti huu muda wowote ule bila kupata adhabu yoyote.

10. **Uwekaji kumbukumbu wa ridhaa**

Nakala moja ya fomu hii iliyosainiwa itawekwa pamoja na kumbukumbu za utafiti huu. Utapewa nakala ya maelezo kuhusu utafiti huu.

_________________________________ _____________________________
Jina la mshiriki Sahihi au alama ya kidole

_________________________________ _____________________________
Jina la anaehoji Sahihi

TAREHE: ____________________

UNIVERSITY OF CAPE TOWN
RISK FACTORS FOR WORK-RELATED ASTHMA IN HEALTH CARE WORKERS WITH EXPOSURE TO DIVERSE CLEANING AGENTS - 2014

ENGLISH QUESTIONNAIRE

Card 1

Survey Number ________________ [ ][ ][ ] 1-3

A. IDENTIFICATION DATA

1.Surname ____________________________________

2. First name/s ____________________________________

3. Address ____
____
____

4. Staff number: ____________________________________ [ ][ ][ ][ ][ ][ ][ ][ ] 4-11

5. Date of birth: Day_____Month______Year________ [ ][ ][ ][ ][ ][ ] 12-17

6. Gender: ___ Male (1) ___ Female (2) [ ] 18

7. Home Language: [ ][ ] 19-20
____ English (1)
____ Afrikaans (2)
____ Xhosa (3)
____ Other (4) ________________________

8. Contact telephone No's:
Home _______________________
Work _______________________
Cell _______________________

9. E-mail address: ____

10. Interviewer's initials ______________________ [ ][ ] 21-22

11. Date of interview: Day_______Month_________Year_________ [ ][ ][ ][ ][ ][ ] 23-28

12. Health facility: ____________________________ [ ] 29

13. Department / Section / Area: ______________________________ [ ][ ] 30-31

14.1 Date of last shift? Day____Month_________Year______ [ ][ ][ ][ ][ ][ ] 32-37

14.2. Did you work today? ___ Yes (1) ___No (2) [ ] 38

If YES, go on to Question 14.3
If NO, skip to next section (Health problems)

14.3 Which shift did you work today?
From ___________ to ___________ [ ] 39

B. HEALTH PROBLEMS

Wheeze and tightness in the chest

1. Have you ***ever*** had wheezing or whistling in your chest in the past?
___ Yes (1) ___No (2) ☐ 40

If YES, go on to Question 1.1
If NO, skip to Question 2

1.1 If yes, when was the first time you had these symptoms.
Date: Month ______ Year _____ ☐☐☐☐ 41-44

1.2 Have you had wheezing or whistling in your chest at any time in the ***last 12 months?*** ___ Yes (1) ___No (2) ☐ 45

If YES, go on to Question 1.2.1
If NO, skip to Question 2

1.2.1 Have you been short of breath when the wheezing noise was present?
___ Yes (1) ___No (2) ☐ 46

1.2.2 Have you had this wheezing or whistling when you did not have a cold or flu? ___ Yes (1) ___No (2) ☐ 47

2. Have you been woken up with a feeling of tightness in your chest at any time in the ***last 12 months?*** ___ Yes (1) ___No (2) ☐ 48

Shortness of breath

3. Have you had an attack of shortness of breath at any time in the ***last 12 months?*** ___ Yes (1) ___No (2) ☐ 49

4. Have you had an attack of shortness of breath that came on during the daytime when you were at rest at any time in the ***last 12 months?***
___ Yes (1) ___No (2) ☐ 50

5. Have you had an attack of shortness of breath that came on following running or exercise at any time in the ***last 12 months?***
___ Yes (1) ___No (2) ☐ 51

6. Have you been woken up by an attack of shortness of breath at any time in the ***last 12 months?*** ___ Yes (1) ___No (2) ☐ 52

Cough and phlegm from the chest

7. Have you been woken up by an attack of coughing at any time in the ***last 12 months?*** ___ Yes (1) ___No (2) ☐ 53

8. Do you usually cough first thing in the morning?
___ Yes (1) ___No (2) ☐ 54

9. Do you usually cough during the rest of the day, or at night?

___ Yes (1) ___No (2) 55

If YES, go on to Question 9.1
If NO, skip to Question 10

9.1 Do you cough like this on most days/nights for as much as **3 or more months** in each of the **last two years?**

___ Yes (1) ___No (2) 56

10. Do you usually bring up any phlegm from your chest first thing in the morning? ___ Yes (1) ___No (2) 57

11. Do you usually bring up any phlegm from your chest during the day, or at night? ___ Yes (1) ___No (2) 58

If YES, go on to Question 11.1
If NO, skip to Question 12

11.1. Do you bring up phlegm like this on most days/nights for as much as **3 or more months** in each of the **last two years?**

___ Yes (1) ___No (2) 59

Breathing

12. Do you ***ever*** have trouble with your breathing?

___ Yes (1) ___No (2) 60

If YES, go on to Question 12.1
If NO, skip to Question 13

12.1 Do you have this trouble:

Give all options at once (3)
Insert a cross (X) next to the most correct answer

61

a) Continuously so that your breathing is never quite right? ____

b) Repeatedly, but it goes away completely between the times when it troubles you? ____

c) Only rarely? ____

13. Are you disabled from walking by a condition other than heart or lung disease? ___ Yes (1) ___No (2) 62

If YES, state the condition _______________________________________ 63
and go on to the next section (Asthma)
If NO, go to Question 13.1

13.1 Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill?

___ Yes (1) ___No (2) 64

If YES, go on to Question 13.1.1
If NO, skip to the next section (Asthma)

13.1.1 Do you notice being short of breath when walking with other people of your own age on level ground?

___ Yes (1) ___No (2) ☐ 65

13.1.2 Do you have to stop for breath when walking at your own pace on level ground?

___ Yes (1) ___No (2) ☐ 66

Asthma

1. Have you ***ever*** had attacks of breathlessness at rest with wheezing in your chest? ___ Yes (1) ___No (2) ☐ 67

2. Have you ***ever*** had asthma? ___ Yes (1) ___No (2) ☐ 68

3. Have you ***ever*** had an asthma attack? ___ Yes (1) ___No (2) ☐ 69

An "asthma attack" is when your asthma symptoms (wheezing, shortness of breath, chest tightness or cough) are worse than usual

If YES to either of questions 1, 2, or 3, go on to Question 4
If NO to questions 1, 2 and 3, skip to the next section (Medical history)

4. Has your asthma been confirmed by a doctor? ___ Yes (1) ___No (2) ☐ 70

5. How old were you when you were told by the doctor that you have asthma?
Give all options at once (3)
Insert a cross (X) next to one answer only

☐ 71

a) Only before you were 17 years old ____
b) Only at the age of 17 years or older ____
c) Both ____

6. Have you had an attack of asthma in the ***last 12 months?***

___ Yes (1) ___No (2) ☐ 72

If YES, go on to Question 6.1
If NO, skip to Question 7

6.1. How many attacks of asthma have you had in the ***last 12 months?***
Enter approximate number: ________ *attacks* ☐☐ 73-74

6.2. How many attacks of asthma have you had in the ***last 3 months?***
Enter approximate number: ________ *attacks* ☐☐ 75-76

7. How old were you when you had your first attack of asthma? Card 2
Enter approximate age: _______ years old ☐☐ 1-2
OR
Enter approximate year: Year ___________ ☐☐☐☐ 3-6

8. How old were you when you had your most recent attack of asthma? | 7-8

Enter approximate age: _______ years old

OR

Enter approximate year: Year ___________ | 9-12

9. Were you employed when you had your first attack of asthma?

___ Yes (1) ___No (2) | 13

If YES, go on to Question 9.1

If NO, skip to Question 10

When you had your first attack of asthma:

9.1 What type of job did you have?

Job title: ____ | 14-15

9.2. What did you do in this job?

Tasks: ____ | 16-17

9.3 What type of company did you work for?

Industry: ____ | 18-19

10. After onset of asthma, did you ***ever*** have a period when you did not have asthma symptoms?

___ Yes (1) ___No (2) | 20

DO NOT record if a participant was using asthma medicines during that period

If YES, go on to Question 10.1

If NO, skip to Question 11

10.1 At what age did your asthma symptoms disappear?

Enter approximate age: _______ years old | 21-22

OR

Enter approximate year: Year ___________ | 23-26

10.2 Did your asthma symptoms reappear? ___ Yes (1) ___No (2) | 27

If YES, go on to Question 10.2.1

If NO, skip to Question 11

10.2.1 At what age did your asthma symptoms reappear?

Enter approximate age: _______ years old | 28-29

OR

Enter approximate year: Year ___________ | 30-33

10.2.2 Were you employed when your asthma symptoms reappeared?

___ Yes (1) ___No (2) | 34

If YES, go on to Question 10.2.2.1

If NO, skip to Question 11

When your symptoms reappeared:
10.2.2.1 What type of job did you have?
Job title: ____ ☐☐ 35-36

10.2.2.2 What did you do in this job?
Tasks: ____ ☐☐ 37-38

10.2.2.3 What type of company did you work for?
Industry: ____ ☐☐ 39-40

11. Which season(s) of the year do you usually have attacks of asthma?

11.1. Winter ___ Yes (1) ___No (2) ___Don't know (3) ☐ 41

11.2. Spring ___ Yes (1) ___No (2) ___Don't know (3) ☐ 42

11.3. Summer ___ Yes (1) ___No (2) ___Don't know (3) ☐ 43

11.4. Autumn ___ Yes (1) ___No (2) ___Don't know (3) ☐ 44

12. Are your chest symptoms caused by, or made worse by any of the following:
Answer all questions

12.1. Contact with animals/pets ___ Yes (1) ___No (2) ☐ 45

12.2. Grass or flowers ___ Yes (1) ___No (2) ☐ 46

12.3. Heavy exercise ___ Yes (1) ___No (2) ☐ 47

12.4. Breathing cold air ___ Yes (1) ___No (2) ☐ 48

12.5. Tobacco smoke ___ Yes (1) ___No (2) ☐ 49

12.6. Change in the weather ___ Yes (1) ___No (2) ☐ 50

12.7. Cleaning agents at home ___ Yes (1) ___No (2) ☐ 51

12.8. Perfumes ___ Yes (1) ___No (2) ☐ 52

13. Have you had to miss any days of work due to asthma in the ***last 12 months?***
___ Yes (1) ___No (2) ☐ 53

If YES, go on to Question 13.1
If NO, skip to Question 14

13.1. How many days of work did you have to miss due to asthma in the ***last 12 months?***
Enter approximate number. __ __ __ days ☐☐☐ 54-56

14. Did you ever go to work in the ***last 12 months*** even though your asthma symptoms were especially bad?

___ Yes (1) ___No (2) ☐57

If YES, go on to Question 14.1
If NO, skip to Question 15

14.1 On how many days in the ***last 12 months*** did you go to work even though your asthma symptoms were especially bad?

Enter approximate number. __ __ __ days ☐☐☐58-60

15. Have you ***ever*** been hospitalized overnight for asthma?

___ Yes (1) ___No (2) ☐61

If YES, go on to Question 15.1
If NO, skip to Question 16

15.1 In the ***last 12 months,*** were you hospitalized overnight for asthma?

___ Yes (1) ___No (2) ☐62

16. In the ***last 12 months,*** did you get urgent treatment for an asthma attack at a doctor's office, urgent care facility, or emergency casualty department?

___ Yes (1) ___No (2) ☐63

Do not count routine planned appointments.
If YES, go on to Question 16.1
If NO, skip to Question 17

16.1. In the ***last 12 months,*** how many times did you get urgent treatment for an asthma attack at a doctor's office, urgent care facility, or emergency casualty department?

Do not count routine planned appointments __ __ times ☐☐64-65

17. Are you using any medicines, including inhalers/pumps, nebulizers, syrups or tablets, for asthma or breathing problems?

___ Yes (1) ___No (2) ☐66

If YES, go on to Question 17.1, showing examples of each
If NO, skip to Question 18

17.1. Which medicines?

____ ☐67
____ ☐68
____ ☐69

17.2. Do you take these medicines every day even when you do not have any trouble breathing?

___ Yes (1) ___No (2) ☐70

17.3. In the ***last 12 months,*** did you use fast-acting or rescue <u>bronchodilators,</u> for example Asthavent or Ventolin, for asthma?

___ Yes (1) ___No (2) ☐71

If YES, go on to Question 17.3.1
If NO, skip to Question 18

17.3.1. In the ***last 12 months,*** were there times when you increased your usage of fast-acting or rescue <u>bronchodilators</u> on a short-term basis, over a period from 2 days to 2 weeks?

___ Yes (1) ___No (2) ☐72

17.4. In the ***last 12 months,*** did you use <u>inhaled steroids,</u> for example Budeflam, Inflammide or Flixotide, for asthma?

___ Yes (1) ___No (2) ☐73

If YES, go on to Question 17.4.1
If NO, skip to Question 17.5

17.4.1. In the ***last 12 months,*** were there times when you increased your usage of <u>inhaled steroids</u> on a short-term basis, over a period from 2 days to 2 weeks?

___ Yes (1) ___No (2) ☐74

17.5. In the ***last 12 months,*** did you use <u>oral steroids,</u> for example Prednisone, for asthma?

___ Yes (1) ___No (2) ☐75

If YES, go on to Question 17.5.1
If NO, skip to Question 18

17.5.1. In the ***last 12 months,*** were there times when you increased your usage of <u>oral steroids</u> on a short-term basis, over a period from 2 days to 2 weeks?

___ Yes (1) ___No (2) ☐76

Current asthma control test

Now I'm going to ask you about your asthma control in the ***past 4 weeks:***

18. In the ***past 4 weeks***, how much of the time did your asthma keep you from getting as much done at work or at home? ☐77

______ All of the time (1)
______ Most of the time (2)
______ Some of the time (3)
______ A little of the time (4)
______ None of the time (5)

19. During the ***past 4 weeks***, how often have you had shortness of breath? ☐78

______ More than once a day (1)
______ Once a day (2)
______ 3 to 6 times a week (3)
______ Once or twice a week (4)
______ Not at all (5)

20. During the ***past 4 weeks,*** how often did your asthma symptoms (wheezing, coughing, shortness of breath, chest tightness or pain) wake you up at night or earlier than usual in the morning? ☐79

______ 4 or more nights a week (1)
______ 2 to 3 nights a week (2)
______ Once a week (3)
______ Once or twice (4)
______ Not at all (5)

21. During the ***past 4 weeks,*** how often have you used your rescue inhaler or nebulizer medication (such as Asthavent or Ventolin)? ☐80

______ 3 or more times per day (1)
______ 1 or 2 times per day (2)
______ 2 or 3 times per week (3)
______ Once a week or less (4)
______ Not at all (5)

Card 3

23. How would you rate your asthma control during the ***past 4 weeks?*** ☐1

______ Not controlled at all (1)
______ Poorly controlled (2)
______ Somewhat controlled (3)
______ Well controlled (4)
______ Completely controlled (5)

Medical History

1. Have you ever been treated for any of the following:

Answer all questions

1.1. Chronic bronchitis ___ Yes (1) ___No (2) ___Don't know (3) ☐2

1.2. Tuberculosis (TB) ___ Yes (1) ___No (2) ___Don't know (3) ☐3

1.3. ***Repeated*** chest infections as a child
___ Yes (1) ___No (2) ___Don't know (3) ☐4

Nose and eye symptoms

1. Have you ***ever*** had any nose or eye problems or allergies such as hay fever?
___ Yes (1) ___No (2) ☐5

If YES, go on to Question 1.1. Answer all questions
If NO, skip to Question 1.4

1.1. How old were you when you first noticed these symptoms?

Enter approximate age: _______ years old ☐☐6-7
OR
Enter approximate year: Year ___________ ☐☐☐☐8-11

1.2 During the ***past 12 months*** have you had ***two or more*** episodes of:

1.2.1 sneezy, itchy or runny nose when you did not have a cold or flu?
___ Yes (1) ___No (2) ☐12

1.2.2 red, itchy or watery eyes ___ Yes (1) ___No (2) ☐13

1.2.3 Do you usually have the nose or eye symptoms at any particular time of the year? ___ Yes (1) ___No (2) ☐14

1.2.3.1. If YES, which is the worst season?

Give all options at once (6)
Insert a cross (X) next to one answer only

1.2.3.1.1. Winter ___ Yes (1) ___No (2) ___Don't know (3) ☐15

1.2.3.1.2. Spring ___ Yes (1) ___No (2) ___Don't know (3) ☐16

1.2.3.1.3. Summer ___ Yes (1) ___No (2) ___Don't know (3) ☐17

1.2.3.1.4. Autumn ___ Yes (1) ___No (2) ___Don't know (3) ☐18

1.3. Are you using any medicines, including nose sprays, drops, tablets or injections, for your nose or eye symptoms at present?

___ Yes (1) ___No (2) ☐19

If YES, go on to Question 1.3.1
If NO, go on to Question 1.4

Present a chart with different samples of allergy medicines
(N.B. a health care worker might show you his/her medicines).

1.3.1. Which medicines?

____ ☐20
____ ☐21
____ ☐22

1.4. Did you have hay fever (itchy or watery eyes/nose) as a child?

___ Yes (1) ___No (2) ___Don't know (3) ☐23

Skin symptoms

1. Have you ***ever*** had any kind of skin problem either at home or at work?

___ Yes (1) ___No (2) ☐24

If YES, go on to Question 1.1
If NO, skip to Question 1.6

1.1. If Yes, what was it?

____ ☐☐25-26
____

1.2. How old were you when you **first** noticed this skin problem?

Enter approximate age: _______ years old ☐☐27-28
OR
Enter approximate year: Year ___________ ☐☐☐☐29-32

1.3. During the ***past 12 months*** have you had any skin problems that occurred ***2 or more times?***

___ Yes (1) ___No (2) ☐33

If Yes, which of the following problems did you have?

Go through each option in the table below and circle the appropriate response.

	Forearms / Hands	Whole body	
1.3.1. Itchy or scratchy skin	___Yes (1) ___No (2)	___Yes (1) ___No (2)	☐34 ☐35
1.3.2. Hives ("bommels")	___Yes (1) ___No (2)	___Yes (1) ___No (2)	☐36 ☐37
1.3.3. Dry, scaly skin	___Yes (1) ___No (2)	___Yes (1) ___No (2)	☐38 ☐39
1.3.4 redness of the skin	___Yes (1) ___No (2)	___Yes (1) ___No (2)	☐40 ☐41
1.3.5. Blisters or weeping skin	___Yes (1) ___No (2)	___Yes (1) ___No (2)	☐42 ☐43
1.3.6. Burning skin	___Yes (1) ___No (2)	___Yes (1) ___No (2)	☐44 ☐45
1.3.7. Rash within an hour of contact with a rubber latex product	___Yes (1) ___No (2)	___Yes (1) ___No (2)	☐46 ☐47
1.3.8.	___Yes (1) ___No (2)	___Yes (1) ___No (2)	☐48 ☐49

Other, specify:____

____

____ ☐50

1.4. Did you develop chest symptoms after experiencing these skin symptoms?

___ Yes (1) ___No (2) ☐51

1.5. Are you using any medicines, including any creams or ointments, for your skin problems at present?

___ Yes (1) ___No (2) ☐52

If YES, go on to Question 1.5.1

If NO, skip to question 1.6

1.5.1. Which medicines?

____ ☐53

____ ☐54

____ ☐55

1.6. Have you ever bruised or injured your fingers or hands while working in the hospital?

___ Yes (1) ___No (2) ☐56

1.7. How many times do you wash your hands in the course of a day?

Enter approximate number. __ __ times/day ☐☐57-58

1.8. Did you have eczema as a child?

___ Yes (1) ___No (2) ___Don't know (3) ☐59

<u>Other allergic conditions</u>

1. Are you allergic to insect stings or bites?

___ Yes (1) ___No (2) ___Don't know (3) ☐60

If YES, go on to Question 1.1
If NO, skip to Question 2

1.1 What kind of reactions do you have?

1.1.1. Breathing difficulty, feeling faint, fever?

___ Yes (1) ___No (2) ☐61

1.1.2 Redness, itching or swelling at the sting site?

___ Yes (1) ___No (2) ☐62

1.1.3 Other: ________________________________ ☐63

2. Have you ever had any difficulty with your breathing after taking medications or injections that you did not have before?

___ Yes (1) ___No (2) ☐64

If YES, go on to Question 2.1
If NO, skip to 3

2.1. Which medicines?

____ ☐65
____ ☐66

3. Have you ***ever*** had any symptoms related to latex products such as gloves, catheters, etc.? ___ Yes (1) ___No (2) ☐67

If YES, go on to Question 3.1
If NO, skip to question 4

3.1. If Yes, which symptoms did you experience?

3.1.1. Itchy or scratchy skin	___ Yes (1)	___No (2)	☐68
3.1.2. Hives ("bommels")	___ Yes (1)	___No (2)	☐69
3.1.3. Blistering or weeping skin	___ Yes (1)	___No (2)	☐70
3.1.4. Breathlessness/tight chest/wheeze	___ Yes (1)	___No (2)	☐71
3.1.5. Sneezing, itchy, stuffy or runny nose	___ Yes (1)	___No (2)	☐72
3.1.6. Red, itchy or watery eyes	___ Yes (1)	___No (2)	☐73
3.1.7. "Collapsed" / fainted	___ Yes (1)	___No (2)	☐74

3.2. Have you ever being diagnosed with latex allergy? ___ Yes (1) ___No (2) ☐75

If YES, go on to Question 3.2.1
If NO, skip to question 4

3.2.1. If Yes, when was it? Card 4

Enter approximate age: _______ years old ☐☐1-2

OR

Enter approximate year: Year ___________ ☐☐☐☐3-6

4. Have you ever had an illness, health problem or allergy caused by eating a particular type of food /fruit?

___ Yes (1) ___No (2) ___Don't know (3) ☐ 7

If YES, go on to Question 4.1
If NO, skip to question 5

4.1 What type of food/fruit was this?
____ ☐☐ 8-9

4.1. Did this illness or health problem include:

4.1.1 Itchy skin or rash	___ Yes (1)	___No (2)	☐ 10
4.1.2 Diarhoea or vomiting	___ Yes (1)	___No (2)	☐ 11
4.1.3 Runny or stuffy nose	___ Yes (1)	___No (2)	☐ 12
4.1.4 Severe headaches	___ Yes (1)	___No (2)	☐ 13
4.1.5 Breathlessness/tight chest/wheeze	___ Yes (1)	___No (2)	☐ 14
4.1.6 Other:____			☐ 15
4.2 Was the food canned or preserved?	___ Yes (1)	___No (2)	☐ 16
4.3 Do you experience these problems when you drink fizzy drinks also?	___ Yes (1)	___No (2)	☐ 17
5. Have you ever had a surgical or dental operation that required you to be in theatre?	___ Yes (1)	___No (2)	☐ 18

6. When you are near animals (such as cats, dogs or horses),
OR near trees, grass or flowers or when there is a lot of pollen around,
OR near pillows, quilts or duvets, or in a dusty part of the house, do you ***ever:***

6.1 Start to cough?	___ Yes (1)	___No (2)	☐ 19
6.2 Start to wheeze?	___ Yes (1)	___No (2)	☐ 20
6.3 Get a tight chest?	___ Yes (1)	___No (2)	☐ 21
6.4 Start to feel short of breath?	___ Yes (1)	___No (2)	☐ 22
6.5 Get a runny/stuffy nose or sneeze?	___ Yes (1)	___No (2)	☐ 23
6.6 Get itchy or watery eyes?	___ Yes (1)	___No (2)	☐ 24
6.7 Get itchy skin/rash?	___ Yes (1)	___No (2)	☐ 25

C. FAMILY HISTORY

1. Do or did any members of your family (blood relatives) ever have any kind of allergies?

Do not include relatives by marriage
If family history is completely unknown (subject is adopted, etc.), mark 'Unknown' and do not complete table. Move to next section

___ Yes (1) ___No (2) ___Unknown (3) ☐ 26

If YES, complete table below. Insert a cross (X) in the appropriate block for each option
If NO, skip to the next section (Smoking history)

Type of allergy:	Parent	Sibling	Child	
1.1 Hay fever	1	2	3	☐☐☐ 27-29
1.2 Eczema	1	2	3	☐☐☐ 30-32
1.3 Asthma	1	2	3	☐☐☐ 33-35
1.4 Food related (e.g. fruit, shellfish, spices)	1	2	3	☐☐☐ 36-38
1.5 Other allergy,	1	2	3	☐☐☐ 39-41

Specify: ________________________________

D. SMOKING HISTORY

1. Have you ***ever*** smoked tobacco (cigarettes or pipe) for as long as a ***year?***

'YES' means at least 20 packs of cigarettes or 360 grams of tobacco in a lifetime or at least one cigarette per day for one year

___ Yes (1) ___No (2) ☐ 42

If YES, go on to Question 1.1
If NO, skip to Question 2

1.1. How old were you when you started smoking ***regularly?***

Enter approximate age: _______ years old ☐☐ 43-44
OR
Enter approximate year: Year ___________ ☐☐☐☐ 45-48

1.2 Do you smoke at present?
'YES' means smoking tobacco in the ***last month or more***

___ Yes (1) ___No (2) ☐ 49

If YES, go on to Question 1.2.1
If NO, skip to Question 1.3

1.2 How much do you now smoke on average?

1.2.1 Number of cigarettes per day ____ ____ ☐☐ 50-51

1.2.2 Pipe tobacco in grams/week ___ ___ ___ ☐☐☐ 52-54

1.3. Have you ***ever*** stopped smoking completely? ___ Yes (1) ___No (2) ☐ 55

If YES, go on to Question 1.3.1
If NO, skip to Question 1.4

1.3.1. How old were you when you stopped smoking completely?

Enter approximate age: _______ years old ☐☐ 56-57
OR
Enter approximate year: Year ___________ ☐☐☐☐ 58-61

1.3.1.1 How many years in total did you smoke cigarettes?
(Do not include the years the participant stopped before they started again.)

____ ____ years ☐☐ 62-63

1.3.2 On average of the entire time you smoked, how much did you smoke?

1.3.2.1 Number of cigarettes per day ___ ___ ☐☐ 64-65

1.3.2.2 Pipe tobacco in grams/week ___ ___ ___ ☐☐☐ 66-68

1.4. Do you or did you inhale the smoke? ___ Yes (1) ___No (2) ☐ 69

2. Have you been ***regularly*** exposed to tobacco smoke from other people smoking cigarettes or pipe in the ***last 12 months?***

___ Yes (1) ___No (2) ☐ 70

'Regularly' means on most days or nights

E. HEALTH AND SAFETY EDUCATION AND TRAINING

1. Are you aware of any health problems caused by the chemicals that you work with? ___ Yes (1) ___No (2) ___Don't know (3) — 71

If YES, go on to Question 1.1
If NO, skip to Question 2

1.1. If Yes, what are these problems? ____________________________________ — 72-73

____

____

2. Are you aware of any protective measures to protect your health and the health of others at work? ___ Yes (1) ___No (2) ___Don't know (3) — 74

If YES, go on to Question 2.1
If NO, skip to Question 3

2.1. If Yes, what are these measures? ____________________________________ — 75-76, 77-78

____

____

3. Are there any protective measures currently in place in this hospital?
___ Yes (1) ___No (2) ___Don't know (3) — 79

If Yes, go on to Question 3.1
If NO, continue to 4

Card 5

3.1. If Yes, what are these measures? ____________________________________ — 1-2, 3-4

____

____

3.2. How would you rate these protective measures that are in place, on a scale of 1-5? — 5

_____ 3.2.1. Very poor (1)
_____ 3.2.2. Poor (2)
_____ 3.2.3. Adequate (3)
_____ 3.2.4. Good (4)
_____ 3.2.5. Very good (5)

4. Have you had any health and safety training on working with chemicals in the hospital?

___ Yes (1) ___No (2) ___Don't know (3) ☐ 6

If YES, go on to Question 4.1
If NO, skip to the next section (Home environment)

4.1. Did you receive this training on induction?

___ Yes (1) ___No (2) ___Don't know (3) ☐ 7

4.2. How often do you receive health and safety training on working with chemicals? ☐ 8

_____ 4.2.1. Less than once a year
_____ 4.2.2. Once a year
_____ 4.2.3. More than once a year

4.3. How would rate the health and safety training you received, on a scale of 1-5? ☐ 9

_____ 4.3.1. Very poor (1)
_____ 4.3.2. Poor (2)
_____ 4.3.3. Adequate (3)
_____ 4.3.4. Good (4)
_____ 4.3.5. Very good (5)

F. HOME ENVIRONMENT

The following questions are about the house or apartment where you currently live.

1. In the last ***12 months,*** have you observed any of the following at home?

1.1. Water leakage or water damage indoors on walls, floors, or ceilings?
___ Yes (1) ___No (2) ___Don't know (3) ☐ 10

1.2. Visible mold growth indoors on walls, floors, or ceilings (not on food)?
___ Yes (1) ___No (2) ___Don't know (3) ☐ 11

1.3. Smell of mold or mildew (not from food)?
___ Yes (1) ___No (2) ___Don't know (3) ☐ 12

2. In the ***last 12 months,*** have there been any renovations or construction at home? ___ Yes (1) ___No (2) ☐ 13

3. In the ***last 12 months,*** how often have you personally cleaned your own home?

Never	< 1 day /week	1-2 days /week	3-4 days / week	5-7 days / week
(a)	(b)	(c)	(d)	(e)

☐ 14

If 'NEVER': Go to the next section (Accidental chemical spill or gas release)
If any answer other than 'NEVER': Go to Questions 4

4. In the ***last 12 months,*** on how many days a week have you used the following cleaning products in your own home?

Mark the single best answer for each cleaning product.

	Never	< 1 day /week	1-2 days /week	3-4 days / week	5-7 days / week	
4.1. Bleach, like Domestos, Jik	1	2	3	4	5	☐ 15
4.2. Ammonia products, like Handy Andy	1	2	3	4	5	☐ 16
4.3. Window cleaners, like Windolene	1	2	3	4	5	☐ 17
4.4. Air freshening sprays, like Glade	1	2	3	4	5	☐ 18
4.5. Any spray cleaning product	1	2	3	4	5	☐ 19

G. ACCIDENTAL CHEMICAL SPILL OR RELEASE

1. Were you **ever** involved ***in or near*** an accidental chemical spill or release at home, work, or elsewhere that required you to receive medical care?

___ Yes (1)   ___No (2)   ___Don't know (3)   ☐20

If YES, go on to Question 1.1
If NO, skip to the next section (Employment history)

1.1. In what year did the most recent accidental chemical spill or release occur?

__ __ __ __ Year   ☐☐☐☐21-24

1.2. Where did this most recent accidental chemical spill or release occur?

Please mark one location

____Home (1) ____Work (2) ____Elsewhere (3)   ☐25

1.3. What were you exposed to?

Specify the name/s of the chemical

____   ☐☐26-27

1.4. In the first 24 hours following the most recent accidental exposure, did you experience any respiratory symptoms such as shortness of breath, wheezing, cough, or tightness in your chest?

___ Yes (1)   ___No (2)   ___Don't know (3)   ☐28

If YES, go on to Question 1.5
If NO, skip to the next section (Employment history)

1.5. When you experienced respiratory symptoms in the first 24 hours following the most recent accidental chemical spill or release, how long did these symptoms last?   ☐29

Don't know	< 1 week	1 week to 1 month	>1 month but <3 months	3 months or longer
1	2	3	4	5

H. EMPLOYMENT HISTORY

History of Healthcare Work

1. Please tell me the ***age*** when you started working in the healthcare industry OR the age you began as a healthcare student, whichever was earlier.

Enter approximate age: _______ years old ☐☐ 30-31

OR

Enter approximate year: Year ___________ ☐☐☐☐ 32-35

2. How many ***total years*** have you worked in healthcare? Include years you were a healthcare student.

_______ total years ☐☐ 36-37

Current Employment

3. What is your current job title? ☐☐ 38-39

_____ 3.1. Registered nurse
_____ 3.2. Enrolled nurse
_____ 3.3. Nurse assistant
_____ 3.4. Cleaner
_____ 3.5. Clerk
_____ 3.6. Porter
_____ 3.7. Technician, specify: _______________________________________

4. Which department/ unit/ section are you working in? ☐☐ 40-41

OUT-PATIENT CLINICS

_____ 1. Respiratory (E16)
_____ 2. Cardiac (E17)
_____ 3. GIT (E23)
_____ 4. Urology (E26)
_____ 5. ENT
_____ 6. Eye
_____ 7. Surgery
_____ 8. Oral & Maxillofacial
_____ 9. Gynae colposcopy

WARDS

_____ 10. ENT ward (F8)
_____ 11. Hemodialysis Lab/ward (E13)

TRAUMA & EMERGENCY

_____ 12. Trauma (C14)
_____ 13. Emergency (C15)
_____ 14. Gynae. Emergency (C24)

OTHER:

_____ 15. ICU, specify ____
_____ 16. Theatre, specify ____
_____ 17. Vascular radiology (C8)
_____ 18. Other, specify: ____

5. ***How long*** have you been working in this department/section/area?

Years ______ 42-43

Months _____ 44-45

6. How many ***hours per week*** do you work in your *current* job?

__ __ hours per week 46-47

7. In this job, do you experience ***regular*** exposure to ***any*** of the following: vapours, gases, dust, or fumes? ___ Yes (1) ___No (2) ___Don't know (3) 48

'Regularly' means on most working days

If YES, go on to Question 7.1

If NO, skip to Question 8

7.1. To what vapours, gases, dusts, or fumes are you exposed ***regularly?***

____ 49-50

____ 51-52

8. In the ***last 12 months,*** did you observe any of the following in the area(s) where ***you work?***

8.1 Water leakage or water damage indoors on walls, floors, or ceilings?

___ Yes (1) ___No (2) ___Don't know (3) 53

8.2 Visible mold growth (not on food) indoors on walls, floors, or ceilings?

___ Yes (1) ___No (2) ___Don't know (3) 54

8.3 Smell of mold or mildew (not from food)?

___ Yes (1) ___No (2) ___Don't know (3) 55

9. In the last ***12 months,*** did you observe any of the following renovations or construction ***in, or next*** to, the area(s) where you ***work?***

9.1. Painting walls and fixtures?

___ Yes (1) ___No (2) ___Don't know (3) 56

9.2. Ripping out and replacing walls, woodwork, and partitions?

___ Yes (1) ___No (2) ___Don't know (3) 57

9.3. Ripping out and replacing floors, carpets, and fixed furniture?

___ Yes (1) ___No (2) ___Don't know (3) 58

9.4. Other, specify: ____

____ 59

Use of Liquid Hand Soaps / Sanitizers

Thinking about your current job and what you have done in this job in the ***last 12 months*** *:*

10. Do you use ***liquid*** hand soaps/sanitisers to wash or disinfect your hands? ___ Yes (1) ___No (2) ☐ 60

If YES, go on to Question 10.1
If NO, skip to Question 11

10.1. Which products do you use ***at work?***

- 10.1.1. Chlorhexidine containing products such as Bioscrub, Steriscrub, D-germ, or Biotane in alcohol ___ Yes (1) ___No (2) ☐ 61
- 10.1.2. FRESH liquid hand soap ___ Yes (1) ___No (2) ☐ 62
- 10.1.3. SPARKEM hand soap liquid ___ Yes (1) ___No (2) ☐ 63
- 10.1.4. Other products ____ ☐ 64

____

10.1.1. How many times on a ***typical day,*** do you use these products ***at work?***

- 10.1.1.1. Chlorhexidine containing products such as Bioscrub, Steriscrub, D-germ, or Biotane in alcohol _____ times/day ☐☐ 65-66
- 10.1.1.2. FRESH Liquid hand soap _____ times/day ☐☐ 67-68
- 10.1.1.3. SPARKEM hand soap liquid _____ times/day ☐☐ 69-70
- 10.1.1.4. Other products ______________________________ _____ times/day ☐☐ 71-72

____ _____ times/day ☐☐ 73-74

10.2. Which products do you use ***at home?***

____ ☐☐ 75-76

____ ☐☐ 77-78

10.2.1. How many times on a ***typical day,*** do you use these products ***at home?***

Card 6

____ _____ times/day ☐☐ 1-2

____ _____ times/day ☐☐ 3-4

<u>Cleaning / Sterilizing Medical Instruments</u>

Thinking about your current job and what you have done in this job in the ***last 12 months*** *:*

11. At work, do you ***clean, sterilise or conduct high-level disinfection*** of ***medical*** instruments such as bronchoscopes, laryngoscopes, endoscposes, cystoscopes,
OR metal instruments (needle holder, forceps, etc.),
OR plastic instruments such as ear specula for ear examination?

___ Yes (1) ___No (2) ☐5

IF RESPONDENT DOESN'T KNOW, PROBE: To the best of their knowledge.
If YES: go on to Question 11.1
If NO, skip to Question 11.2

11.1. At work, which of the following ***products*** do you use to **<u>sterilize or high-level disinfect medical instruments?</u>**

Chemical name or product

11.1.1. Ortho-phthalaldehydes such as Cidex OPA®, or Cidex OPA® C

___ Yes (1) ___No (2) ___Don't know (3) ☐6

11.1.2. Glutaraldehydes such as Cidex®

___ Yes (1) ___No (2) ___Don't know (3) ☐7

11.1.3. Enzymatic cleaners, such as Endozime®, or Biozyme®

___ Yes (1) ___No (2) ___Don't know (3) ☐8

11.1.4. Chlorhexidine containing products such as Bioscrub, D-germ, Biotane in alcohol, or Steriscrub

___ Yes (1) ___No (2) ___Don't know (3) ☐9

11.1.5. Quaternary ammonium compounds such as MEDDIS®

___ Yes (1) ___No (2) ___Don't know (3) ☐10

11.1.6. Peracetic acid

___ Yes (1) ___No (2) ___Don't know (3) ☐11

11.1.6. Acetic acid

___ Yes (1) ___No (2) ___Don't know (3) ☐12

11.1.7. Hydrogen peroxide

___ Yes (1) ___No (2) ___Don't know (3) ☐13

11.1.8. Surgislip®

___ Yes (1) ___No (2) ___Don't know (3) ☐14

11.1.9. Surgistain®

___ Yes (1) ___No (2) ___Don't know (3) ☐15

11.1.10. Alcohol, such as ethyl alcohol 96% (ethanol), isopropanol, methylated spirits, alcohol 50%, or 70%

___ Yes (1) ___No (2) ___Don't know (3) ☐16

11.1.11. Bleach or chlorine, such as Domestos®, Medisure®, Biocide D®, or Clorox®

___ Yes (1) ___No (2) ___Don't know (3) ☐17

11.1.12. Bicarbonate concentrate 8.4%

___ Yes (1) ___No (2) ___Don't know (3) ☐18

11.1.13. Citric acid 50%

___ Yes (1) ___No (2) ___Don't know (3) ☐19

11.1.14. Citrosteril

___ Yes (1) ___No (2) ___Don't know (3) ☐20

11.1.15. Renalin 100

___ Yes (1) ___No (2) ___Don't know (3) ☐21

11.1.16. Tiutol KF

___ Yes (1) ___No (2) ___Don't know (3) ☐22

11.1.17. Do you use any **other products** to sterilize or high level-disinfect medical instruments?

___ Yes (1) ___No (2) ☐23

IF 'NO': GO TO QUESTION 11.2
IF 'YES': CONTINUE WITH QUESTION 11.1.17.1

11.1.17.1. What other products do you use?

(i) ____ ☐☐24-25

(ii) ____ ☐☐26-27

11.1.18. If Yes to *any* of the above in question 11.1, complete a separate sheet of paper for each product

Tasks

11.2. In the ***last 12 months,*** have you ever prepared medical instruments for sterilization by manually disassembling instruments, removing gross contaminants, or flushing gross contaminants and waste?

___ Yes (1)   ___No (2)   ___Don't know (3)   ☐ 28

IF 'NO': GO TO QUESTION 11.3
IF 'YES': CONTINUE WITH QUESTION 11.2.1

11.2.1. When you remove gross contaminants and waste from scopes and instruments, please indicate how many days per week, times per day, and the duration when you perform this task.

11.2.1.1.	How many ***days per week*** do you perform this task? __________					29
11.2.1.2.	How many ***times per day*** do you perform this task? __________					30-31
11.2.1.3.	What is the ***duration*** of this task? __________ (hours)					32-33
11.2.1.4.	Gloves used?		Yes (1)	No (2)		34
11.2.1.4.1.	Type?	Latex (1)	Nitrile (2)	Vinyl (3)	Yellow domestic (4)	35
11.2.1.5.	Respirator used?		Yes (1)	No (2)		36
11.2.1.5.1.	What type of a respirator?					37
	Surgical mask				1	
	Particulate respirator such as an N95				2	
	Air purifying half mask				3	
	Air purifying full face piece				4	
	Powered air purifying				5	
11.2.1.6.	What type of ***ventilation*** exist in the work area when you do this task?					
11.2.1.6.1.	Local exhaust ventilation with hood and duct ___ Yes (1) ___No (2) ___Don't know (3)					38
11.2.1.6.2.	Extractor fans in the ceiling ___ Yes (1) ___No (2) ___Don't know (3)					39
11.2.1.6.3.	Fan pushing contaminated air away from worker/s ___ Yes (1) ___No (2) ___Don't know (3)					40
11.2.1.6.4.	Natural ventilation (open doors/windows) ___ Yes (1) ___No (2) ___Don't know (3)					41

11.3. In the ***last 12 months,*** have you ever ***prepared*** cleaning solutions for e.g. by diluting or mixing cleaning products?

___ Yes (1) ___No (2) ___Don't know (3) 42

IF 'NO': GO TO QUESTION 11.4
IF 'YES': CONTINUE WITH QUESTION 11.3.1

11.3.1 When you ***prepare cleaning solutions***, please indicate how many days per week, times per day, and the duration when you perform this task.

11.3.1.1.	How many ***days per week*** do you perform this task? __________					43
11.3.1.2.	How many ***times per day*** do you perform this task? __________					44-45
11.3.1.3.	What is the ***duration*** of this task? __________ (hours)					46-47
11.3.1.4.	Gloves used?		Yes (1)	No (2)		48
11.3.1.4.1.	Type?	Latex (1)	Nitrile (2)	Vinyl (3)	Yellow domestic (4)	49
11.3.1.5.	Respirator used?		Yes (1)	No (2)		50
11.3.1.5.1.	What type of a respirator?					51
	Surgical mask				1	
	Particulate respirator such as an N95				2	
	Air purifying half mask				3	
	Air purifying full face piece				4	
	Powered air purifying				5	

11.3.1.6. What type of ***ventilation*** exist in the work area when you do this task?

11.3.1.6.1. Local exhaust ventilation with hood and duct

___ Yes (1) ___No (2) ___Don't know (3) 52

11.3.1.6.2. Extractor fans in the ceiling

___ Yes (1) ___No (2) ___Don't know (3) 53

11.3.1.6.3. Fan pushing contaminated air away from worker/s

___ Yes (1) ___No (2) ___Don't know (3) 54

11.3.1.6.4. Natural ventilation (open doors/windows)

___ Yes (1) ___No (2) ___Don't know (3) 55

11.4. In the ***last 12 months,*** have you ever prepared medical instruments for sterilization by ***changing sterilization solutions?***

___ Don't know (3) ___ No (2) ___Yes (1) ☐ 56

IF 'NO': GO TO QUESTION 11.5
IF 'YES': CONTINUE WITH QUESTION 11.4.1

11.4.1 When you ***change sterilization solutions,*** please indicate how many days per week, times per day, and the duration when you perform this task.

11.4.1.1.	How many ***days per week*** do you perform this task? __________					☐ 57
11.4.1.2.	How many ***times per day*** do you perform this task? __________					☐☐ 58-59
11.4.1.3.	What is the ***duration*** of this task? __________ (hours)					☐☐ 60-61
11.4.1.4.	Gloves used?		Yes (1)	No (2)		☐ 62
11.4.1.4.1.	Type?	Latex (1)	Nitrile (2)	Vinyl (3)	Yellow domestic (4)	☐ 63
11.4.1.5.	Respirator used?		Yes (1)	No (2)		☐ 64
11.4.1.5.1.	What type of a respirator?					☐ 65
	Surgical mask				1	
	Particulate respirator such as an N95				2	
	Air purifying half mask				3	
	Air purifying full face piece				4	
	Powered air purifying				5	
11.4.1.6.	What type of ***ventilation*** exist in the work area when you do this task?					
11.4.1.6.1.	Local exhaust ventilation with hood and duct ___ Yes (1) ___No (2) ___Don't know (3)					☐ 66
11.4.1.6.2.	Extractor fans in the ceiling ___ Yes (1) ___No (2) ___Don't know (3)					☐ 67
11.4.1.6.3.	Fan pushing contaminated air away from worker/s ___ Yes (1) ___No (2) ___Don't know (3)					☐ 68
11.4.1.6.4.	Natural ventilation (open doors/windows) ___ Yes (1) ___No (2) ___Don't know (3)					☐ 69

11.5. In the ***last 12 months,*** have you ever used a sterilants immersion container to ***manually sterilize or high-level disinfect medical instruments*** ? 70

___ Don't know (3) ___ No (2) ___Yes (1)

IF 'NO': GO TO QUESTION 11.6
IF 'YES': CONTINUE WITH QUESTION 11.5.1

11.5.1 When you use a sterilants immersion container to ***manually sterilize or high-level disinfect*** medical instruments, please indicate how many days per week, times per day, and the duration when you perform this task.

11.5.1.1.	How many ***days per week*** do you perform this task? __________					71
11.5.1.2.	How many ***times per day*** do you perform this task? __________					72-73
11.5.1.3.	What is the ***duration*** of this task? __________ (hours)					74-75
11.5.1.4.	Gloves used?		Yes (1)	No (2)		76
11.5.1.4.1.	Type?	Latex (1)	Nitrile (2)	Vinyl (3)	Yellow domestic (4)	77
11.5.1.5.	Respirator used?		Yes (1)	No (2)		78
11.5.1.5.1.	What type of a respirator?					79
	Surgical mask				1	
	Particulate respirator such as an N95				2	
	Air purifying half mask				3	
	Air purifying full face piece				4	
	Powered air purifying				5	
11.5.1.6.	What type of ***ventilation*** exist in the work area when you do this task?					Card 7
11.5.1.6.1.	Local exhaust ventilation with hood and duct ___ Yes (1) ___No (2) ___Don't know (3)					1
11.5.1.6.2.	Extractor fans in the ceiling ___ Yes (1) ___No (2) ___Don't know (3)					2
11.5.1.6.3.	Fan pushing contaminated air away from worker/s ___ Yes (1) ___No (2) ___Don't know (3)					3
11.5.1.6.4.	Natural ventilation (open doors/windows) ___ Yes (1) ___No (2) ___Don't know (3)					4

11.6. In the ***last 12 months*** , have you ever ***sterilized medical instruments using automated systems*** ?

___ Yes (1) ___No (2) ___Don't know (3) ☐ 5

IF 'NO': GO TO QUESTION 12
IF 'YES': CONTINUE WITH QUESTION 11.6.1

11.6.1. Which tasks do you perform to ***sterilize medical instruments using automated systems?***

Do you perform this task?

11.6.1.1. Operate Cidex OPA® system

___ Yes (1) ___No (2) ___Don't know (3) ☐ 6

11.6.1.2. Operate other system

___ Yes (1) ___No (2) ___Don't know (3) ☐ 7

Specify: ____ ☐ 8

11.6.2. Do you conduct maintenance on the automated system, such as cleaning or replacing screens and filters?

___ Yes (1) ___No (2) ___Don't know (3) ☐ 9

Please indicate how many days per week, times per day, duration of task, and if there is a device that captures and removes gases and vapours from the automated system.

11.6.3. Operate Cidex OPA® system ☐ 10

11.6.3.1.	How many ***days per week*** do you perform this task? __________						11
11.6.3.2.	How many ***times per day*** do you perform this task? __________						12-13
11.6.3.3.	What is the ***duration*** of this task? __________ (hours)						14-15
11.6.3.4.	Gloves used?			Yes (1)	No (2)		16
11.6.3.4.1.	Type?	Latex (1)	Nitrile (2)	Vinyl (3)	Yellow domestic (4)		17
11.6.3.5.	Respirator used?			Yes (1)	No (2)		18
11.6.3.5.1.	What type of a respirator?						19
	Surgical mask					1	
	Particulate respirator such as an N95					2	
	Air purifying half mask					3	
	Air purifying full face piece					4	
	Powered air purifying					5	

11.6.3.6.	What type of ***ventilation*** exist in the work area when you do this task?	
11.6.3.6.1.	Local exhaust ventilation with hood and duct ___ Yes (1) ___No (2) ___Don't know (3)	20
11.6.3.6.2.	Extractor fans in the ceiling ___ Yes (1) ___No (2) ___Don't know (3)	21
11.6.3.6.3.	Fan pushing contaminated air away from worker/s ___ Yes (1) ___No (2) ___Don't know (3)	22
11.6.3.6.4.	Natural ventilation (open doors/windows) ___ Yes (1) ___No (2) ___Don't know (3)	23

11.6.4. Operate other system: ______________________ 24

11.6.4.1.	How many ***days per week*** do you perform this task? __________					25
11.6.4.2.	How many ***times per day*** do you perform this task? __________					26-27
11.6.4.3.	What is the ***duration*** of this task? __________ (hours)					28-29
11.6.4.4.	Gloves used?			Yes (1)	No (2)	30
11.6.4.4.1.	Type?	Latex (1)	Nitrile (2)	Vinyl (3)	Yellow domestic (4)	31
11.6.4.5.	Respirator used?			Yes (1)	No (2)	32
11.6.4.5.1.	What type of a respirator?					33
	Surgical mask				1	
	Particulate respirator such as an N95				2	
	Air purifying half mask				3	
	Air purifying full face piece				4	
	Powered air purifying				5	

11.6.4.6.	What type of ***ventilation*** exist in the work area when you do this task?	
11.6.4.6.1.	Local exhaust ventilation with hood and duct ___ Yes (1) ___No (2) ___Don't know (3)	34
11.6.4.6.2.	Extractor fans in the ceiling ___ Yes (1) ___No (2) ___Don't know (3)	35
11.6.4.6.3.	Fan pushing contaminated air away from worker/s ___ Yes (1) ___No (2) ___Don't know (3)	36
11.6.4.6.4.	Natural ventilation (open doors/windows) ___ Yes (1) ___No (2) ___Don't know (3)	37

Cleaning Fixed Surfaces, Equipment or Instruments

Thinking about your current job and what you have done in this job in the ***last 12 months*** *:*

12. At work, do you clean or disinfect fixed surfaces, equipment, or instruments?

Examples of fixed surfaces are: countertops, floors, beds and bathrooms
Examples of equipment are: IV poles, monitors, trolleys and computers
Examples of instruments are: blood pressure cuffs and stethoscopes

___ Yes (1) ___No (2) ☐38

IF RESPONDENT DOESN'T KNOW, PROBE: To the best of their knowledge.
If YES: go on to Question 12.1
If NO, skip to Question 15

12.1. At work, which products do you use to clean and disinfect fixed surfaces, equipment, or instruments?

Chemical name or product

12.1.1. Alcohol, such as ethyl alcohol 96% (ethanol), isopropanol, methylated spirits, alcohol 50%, or 70%
___ Yes (1) ___No (2) ___Don't know (3) ☐39

12.1.2. Ammonia, such as Handysan, or Ammonia cleaner (cleaner all purpose)
___ Yes (1) ___No (2) ___Don't know (3) ☐40

12.1.3. Bleach or chlorine, such as Domestos®, Medisure®, Biocide D, or Clorox®
___ Yes (1) ___No (2) ___Don't know (3) ☐41

12.1.4. Utensils cleaning products such as SPARKLE dishwashing liquid, or Liquid soap ___ Yes (1) ___No (2) ___Don't know (3) ☐42

12.1.5. Phenolics, such as MEDIFEN Phenolic disinfectant
___ Yes (1) ___No (2) ___Don't know (3) ☐43

12.1.6. Enzymatic cleaners such as Endozime®, or Biozyme®
___ Yes (1) ___No (2) ___Don't know (3) ☐44

12.1.7. Floor wax strippers, such as Multistrip®, or RADICAL Non-ammoniated floor stripper ___ Yes (1) ___No (2) ___Don't know (3) ☐45

12.1.8. Floor sealer/wax, such as buff spray (diluted floor sealer/wax), Vision gold®, or Claro-cote® ___ Yes (1) ___No (2) ___Don't know (3) ☐46

12.1.9. Glass cleaning products such as Liquid soap, or Windex®
___ Yes (1) ___No (2) ___Don't know (3) ☐47

12.1.10. SPARKEM Scouring paste
___ Yes (1) ___No (2) ___Don't know (3) ☐48

12.1.11. Air freshener, such as Biocidol disinfectant (Ocean Cherry), air freshener without disinfectant, or DUX ___ Yes (1) ___No (2) ___Don't know (3) 49

12.1.12. Carpet shampoo
___ Yes (1) ___No (2) ___Don't know (3) 50

12.1.13. Furniture polish
___ Yes (1) ___No (2) ___Don't know (3) 51

12.1.14. M4 paste
___ Yes (1) ___No (2) ___Don't know (3) 52

12.1.15. Stainless steel cleaner
___ Yes (1) ___No (2) ___Don't know (3) 53

12.1.16. Sumasan
___ Yes (1) ___No (2) ___Don't know (3) 54

12.1.17. Terrazzo cleaner
___ Yes (1) ___No (2) ___Don't know (3) 55

12.1.18. Wall cleaner
___ Yes (1) ___No (2) ___Don't know (3) 56

12.1.19. Washing powder for cleaning floor mops
___ Yes (1) ___No (2) ___Don't know (3) 57

12.1.20. Do you use any **other products** for cleaning fixed surfaces, equipment, or instruments?
Yes (1) No (2) 58

If YES, go on to Question 12.1.20.1
If NO, skip to Question 13

12.1.20.1. What other products do you use?
1. ____ 59-60
2. ____ 61-62

12.1.21. If Yes to *any* of the above in question 12.1, complete a separate sheet of paper for each product

Tasks

*I'm now going to ask you about certain **tasks** you perform at work.*

13. Do you use more ***sprays*** or more ***wipes,*** or do you use both equally often in your work?

Select the ONE best answer.

13.1	Use more sprays than wipes	1
	Use more wipes than sprays	2
	Use sprays and wipes about equally	3
	Not sure which I use more	4

63

14. At work, which tasks do you perform when cleaning or disinfecting fixed surfaces, equipment, or instruments?

14.1. Wipe down beds, furniture, counters, walls, etc.
___ Yes (1) ___No (2) ___Don't know (3) ☐64

14.2. Cleanup blood or cleanup other spills
___ Yes (1) ___No (2) ___Don't know (3) ☐65

14.3. Manually mix, refill, or empty cleaning or disinfecting products
___ Yes (1) ___No (2) ___Don't know (3) ☐66

14.4. Clean bathrooms including toilet, sink, shower
___ Yes (1) ___No (2) ___Don't know (3) ☐67

14.5. Spray then wipe glass, windows, mirrors
___ Yes (1) ___No (2) ___Don't know (3) ☐68

14.6. Polish wood furniture
___ Yes (1) ___No (2) ___Don't know (3) ☐69

14.7. Polish stainless steel surfaces
___ Yes (1) ___No (2) ___Don't know (3) ☐70

14.8. Spray deodorant/ disinfectant
___ Yes (1) ___No (2) ___Don't know (3) ☐71

14.9. Sweep floors
___ Yes (1) ___No (2) ___Don't know (3) ☐72

14.10. Hovering
___ Yes (1) ___No (2) ___Don't know (3) ☐73

14.11. Rug beating
___ Yes (1) ___No (2) ___Don't know (3) ☐74

14.12. Mop floors
___ Yes (1) ___No (2) ___Don't know (3) ☐75

14.13. Clean instruments such as scissors, stethoscopes, and thermometers, or equipment such as IV poles, trolleys, monitors, and computers

___ Yes (1) ___No (2) ___Don't know (3) ☐76

14.14. Conduct terminal cleaning of patient rooms

___ Yes (1) ___No (2) ___Don't know (3) ☐77

14.15. Use fogging equipment with hydrogen peroxide or peracetic acid vapors to conduct terminal cleaning of patient rooms

___ Yes (1) ___No (2) ___Don't know (3) ☐78

14.16. Clean or disinfect for methicillin-resistant staphylococcus aureus, vancomycin-resistant enterococci or other drug resistant bacteria in patient rooms

___ Yes (1) ___No (2) ___Don't know (3) ☐79

14.17. Conduct end of shift cleaning of operating rooms, dialysis units or other patient care areas

___ Yes (1) ___No (2) ___Don't know (3) ☐80

14.18. If Yes to *any* of the above in question 14, complete a separate sheet of paper for each task

15. In the ***last 12 months,*** have you cleaned and ***waxed*** floors using ***strippers*** and ***buffers?*** Card 8

___ Yes (1) ___No (2) ___Don't know (3) ☐1

If YES, go on to Question 15.1
If NO, skip to Question 16

15.1. Which tasks do you perform when cleaning and waxing floors using ***strippers and buffers?***

15.1.1. Strip floors

___ Yes (1) ___No (2) ___Don't know (3) ☐2

15.1.2. Scrape floors

___ Yes (1) ___No (2) ___Don't know (3) ☐3

15.1.3. Buff floors

___ Yes (1) ___No (2) ___Don't know (3) ☐4

15.1.4. Wax floors

___ Yes (1) ___No (2) ___Don't know (3) ☐5

15.1.5. If Yes to *any* of the above in question 15.1, complete a separate sheet of paper for each task

<u>Exposure to chemicals used for specimen preparation</u>

16. Do you ever ***prepare specimes*** for histology or cytology?

___ Yes (1) ___No (2) ___Don't know (3) ☐6

If YES, go on to Question 16.1
If NO, skip to Question 17

16.1 Which of the following products do you use to ***prepare specimens*** for histology/cytology?

16.1.1. Formalin 10% in normal saline

___ Yes (1) ___No (2) ___Don't know (3) ☐7

16.1.2 Fencott cytological fixative spray

___ Yes (1) ___No (2) ___Don't know (3) ☐8

16.1.3. Any stains and dyes such as hematoxylin and eosin stains?

___ Yes (1) ___No (2) ___Don't know (3) ☐9

16.1.4. Any solvents such as xylene and toluene to fix tissue specimens and rinse stains? ___ Yes (1) ___No (2) ___Don't know (3) ☐10

16.1.5. If Yes to *any* of the above in question 16.1, complete a separate sheet of paper for each product

Exposure to Products Used on Patients

Thinking about your current job and what you have done in this job in the ***last 12 months:***

17. Do you use chemical products on patients?

Examples:

***Antiseptics** : alcohols, iodine, acetic acid, silver compounds, chlorhexidine, povidone iodine*

***Adhesives** : glues, acrylates, bone cements*

***Adhesive removing solvents** : alcohols, acetone, ether*

___ Yes (1) ___No (2) ___Don't know (3) ☐ 11

IF RESPONDENT DOESN'T KNOW, PROBE: This is to the best of their knowledge.

If YES, go on to Question 17.1
If NO, skip to Question 18

17.1 Which tasks do you perform when you apply or use chemicals, antiseptics, adhesives, alcohols, or solvents **on patients**?

Tasks:

17.1.1. Disinfect skin areas on patients prior to ***procedure*** using wipes, gauze or swabs with antiseptics such as Biotane in alcohol, povidone iodine, alcohols, acetic acid.

___ Yes (1) ___No (2) ___Don't know (3) ☐ 12

17.1.2. Clean and disinfect ***wounds*** using antiseptics such as silver compounds, Biotane in alcohol, povidone iodine, or cadexomer iodine

___ Yes (1) ___No (2) ___Don't know (3) ☐ 13

17.1.3. Apply ***wound dressing*** such as polyurethane based hydrogel, hydrocolloid, or hydrocellular foam

___ Yes (1) ___No (2) ___Don't know (3) ☐ 14

17.1.4. Use ***adhesives*** such as glues, acrylates, bone cements, benzoin tincture such as Opsite, 3M® Steri-Strip® for surgery, skin closure, bone repair, ostomy bags, and other applications

___ Yes (1) ___No (2) ___Don't know (3) ☐ 15

17.1.5. Use ***adhesive removing solvents*** such as ether, alcohols or acetone with wipes, gauze, or swabs

___ Yes (1) ___No (2) ___Don't know (3) ☐ 16

17.1.6. Apply or remove synthetic fiberglass orthopaedic casts

___ Yes (1) ___No (2) ___Don't know (3) ☐ 17

17.1.7. If Yes to *any* of the above in question 17.1, complete a separate sheet of paper for each task

<u>Exposure to Aerosolized Medicines Used on Patients</u>

Thinking about your current job and what you have done in this job in the last ***12 months*** *:*

18. Do you administer ***aerosolized medications*** such as bronchodilators or anaesthetics?

___ Yes (1) ___No (2) ___Don't know (3) ☐18

IF RESPONDENT DOESN'T KNOW, PROBE: This is to the best of their knowledge.

If YES, go on to Question 18.1
If NO, skip to the next section (Previous employment)

18.1 Which tasks do you perform when you administer ***aerosolized medications?***

Tasks

18.1.1. Administer aerosolized medications with a ***small volume nebulizer (SVN)***

___ Yes (1) ___No (2) ___Don't know (3) ☐19

18.1.2. Use ***continuous aerosol delivery system*** for bronchodilators and other medicines

___ Yes (1) ___No (2) ___Don't know (3) ☐20

18.1.3. Administer aerosolized medications with a ***metered-dose inhaler (MDI)***

___ Yes (1) ___No (2) ___Don't know (3) ☐21

18.1.4. Administer aerosolized medications with a ***dry powder inhaler (DPI)***

___ Yes (1) ___No (2) ___Don't know (3) ☐22

18.1.5. If Yes to *any* of the above in question 18.1, complete a separate sheet of paper for each task

I. PREVIOUS EMPLOYMENT

*Now I am going to ask some questions about your **previous jobs** in **this hospital:***

1. Name all the ***previous jobs*** that you have had ***in this hospital:***

Start with the first job that you had

Department/ Section/ Area	Job Title (what did you do?)	Start date (year)	End date (year)	How many hours/day did you work?	Were you regularly exposed to vapours, gases, gases, dusts, or fumes?

*Now I am going to ask some questions about your previous employment in the healthcare industry, **but not in this hospital***

2. Name all the ***previous healthcare facilities*** where you have worked, when not working in this hospital, or before coming to work in this hospital:

Start with the first job that you had

Name of the work-place	Type	Job Title (what did you do?)	Start date (year)	End date (year)	How many hours/day did you work?	Were you regularly exposed to vapours, gases, gases, dusts, or fumes?

Now I am going to ask some questions about your previous employment ***(outside the healthcare industry)***

3. Name all the previous workplaces where you have worked ***(outside the healthcare industry):***

Start with the most recent job and work backwards (including all other healthcare facilities and the jobs done)

Name of workplace	**Industry**	**Job Title (what did you do?)**	**Start Date (year)**	**End Date (year)**	**Total (years)**

Changing Jobs

4. Have you ever had to <u>change or leave a job or position because it affected your</u> breathing? This would include changing jobs or positions within the same workplace. ☐23

___ Yes (1) ___No (2) ___Don't know (3)

If YES, go on to Question 4.1
If NO, skip to the next section (Work-related symptoms)

Please answer the following questions about the most recent time you changed or left a job or position because it affected your breathing.

4.1. In which **year** did you change or leave this job or position?

Year: __ __ __ __ ☐☐☐☐24-27

4.2. What kind of job or position did you change or leave? ☐☐28-29

____

____

4.3. What were you doing in the job or position you changed or left? __________ ☐☐30-31

____

____

____

4.4. What exposure or activity affected your breathing in the job or position you changed or left? ____ ☐☐32-33

____ ☐☐34-35

4.5. *Concerning the job or position you went to:* What kind of job or position did you go to? ____ ☐☐36-37

____

4.6. What did you do in this new job or position? ☐☐38-39

____

____

4.7. What was the name of the company where you worked at this new job? ☐☐40-41

____

4.8. Did your symptoms improve when you changed job or position?

___ Yes (1) ___No (2) ☐42

J. WORK-RELATED SYMPTOMS

Work-related chest symptoms

Thinking about all your working life and asthma symptoms at work:

1. Does being at work ***ever*** make your chest tight, wheezy, or short of breath?

___ Yes (1) ___No (2) ☐ 43

If YES, go on to Question 1.1
If NO, skip to Question 2

1.1 When did you first notice having these chest symptoms at work?

Date: Month ______ Year _____ ☐☐☐☐ 44-47

1.2. What do you think is causing or triggering these symptoms?

As I read each response, tell me if it applies to you

Workplace triggers

Don't know	__Y(1) __N(2)	☐ 48
Ortho-phthalaldehydes such as Cidex OPA®, Cidex OPA® C	__Y(1) __N(2)	☐ 49
Glutaraldehydes such as Cidex®	__Y(1) __N(2)	☐ 50
Enzymatic cleaners, such as Endozime®, Biozyme®	__Y(1) __N(2)	☐ 51
Chlorhexidine containing products such as Bioscrub, D-germ, Biotane in alcohol, or Steriscrub	__Y(1) __N(2)	☐ 52
Quaternary ammonium compounds such as MEDDIS®	__Y(1) __N(2)	☐ 53
Bleach or chlorine, such as Domestos®, Medisure®, Biocide D®, Clorox®	__Y(1) __N(2)	☐ 54
Ammonia, such as Handysan, Ammonia cleaner (cleaner all purpose)	__Y(1) __N(2)	☐ 55
Other cleaning products for sterilisation/high-level disinfection of medical instruments	__Y(1) __N(2)	☐ 56
Other cleaning products for cleaning fixed surfaces	__Y(1) __N(2)	☐ 57
Floor strippers or waxes	__Y(1) __N(2)	☐ 58
Other liquid hand soaps/sanitisers	__Y(1) __N(2)	☐ 59
Adhesives, glues, or removers of surgical dressings	__Y(1) __N(2)	☐ 60
Aerosolised medicines	__Y(1) __N(2)	☐ 61
Gases or vapour	__Y(1) __N(2)	☐ 62
Latex rubber products	__Y(1) __N(2)	☐ 63
Very cold or very hot temperatures	__Y(1) __N(2)	☐ 64
Dust, please specify (paper dust, etc.): ____________________________	__Y(1) __N(2)	☐ 65
Other, please specify:	__Y(1) __N(2)	☐ 66
a) ______________________________		☐ 67
b) ______________________________		☐ 68
c) ______________________________		☐ 69
d) ______________________________		☐ 70

Thinking about the last 12 months:

1.3. In the ***last 12 months***, have you experienced these chest symptoms while you were at work at any time?

___ Yes (1) ___No (2) ☐71

If YES, go on to Question 1.3.1
If NO, skip to Question 1.4

1.3.1. While you were ***away*** from work (for e.g. on weekends, off-shift, or on vacations) at any time in the ***last 12 months,*** did your chest symptoms seem better, worse, or the same?

Give all options at once (3)
Insert a cross (X) next to one answer only

☐72

a) Stay the same ______
b) Get better ______
c) Get worse ______

1.3.2. After ***returning*** to your ***work*** at any time in the ***last 12 months***, did your chest symptoms seem better, worse, or the same?

Give all options at once (3)
Insert a cross (X) next to one answer only

☐73

a) Stay the same ______
b) Get better ______
c) Get worse ______

1.4. Were you ***ever*** told by a doctor that your asthma was related to any job you ever had?

___ Yes (1) ___No (2) ☐74

If YES, go on to Question 1.4.1
If NO, skip to Question 2

1.4.1. At approximately what ***age or year*** did the doctor first diagnosed it?

Enter approximate age: _______ years old ☐☐75-76
OR
Enter approximate year: Year ___________ ☐☐☐☐77-80

1.4.2. Where were you working at time of the first symptoms?

Card 9
☐1

____ 1. Employed in the healthcare industry
____ 2. Employed outside of the healthcare industry
____ 3. Student, please specify: _____________________________________ ☐2

Work-related nose & eye symptoms

Thinking about all your working life and nose & eye symptoms at work:

2. Does being at work ***ever*** cause you to have sneezy/itchy/runny nose or red/itchy/watery eyes?

___ Yes (1) ___No (2) ☐ 3

If YES to any one of the above, go on to Question 2.1
If NO, skip to Question 3

2.1. Since when have you been having these symptoms at work?

Date: Month ______ Year _____ ☐☐☐☐ 4-7

2.2. What do you think is causing or triggering these symptoms?

As I read each response, tell me if it applies to you

Workplace triggers

Workplace triggers			
Don't know	__Y(1) __N(2)	☐	8
Ortho-phthalaldehydes such as Cidex OPA®, Cidex OPA® C	__Y(1) __N(2)	☐	9
Glutaraldehydes such as Cidex®	__Y(1) __N(2)	☐	10
Enzymatic cleaners, such as Endozime®, Biozyme®	__Y(1) __N(2)	☐	11
Chlorhexidine containing products such as Bioscrub, D-germ, Biotane in alcohol, or Steriscrub	__Y(1) __N(2)	☐	12
Quaternary ammonium compounds such as MEDDIS®	__Y(1) __N(2)	☐	13
Bleach or chlorine, such as Domestos®, Medisure®, Biocide D®, Clorox®	__Y(1) __N(2)	☐	14
Ammonia, such as Handysan, Ammonia cleaner (cleaner all purpose)	__Y(1) __N(2)	☐	15
Other cleaning products for sterilisation/high-level disinfection of medical instruments	__Y(1) __N(2)	☐	16
Other cleaning products for cleaning fixed surfaces	__Y(1) __N(2)	☐	17
Floor strippers or waxes	__Y(1) __N(2)	☐	18
Other liquid hand soaps/sanitisers	__Y(1) __N(2)	☐	19
Adhesives, glues, or removers of surgical dressings	__Y(1) __N(2)	☐	20
Aerosolised medicines	__Y(1) __N(2)	☐	21
Gases or vapour	__Y(1) __N(2)	☐	22
Latex rubber products	__Y(1) __N(2)	☐	23
Very cold or very hot temperatures	__Y(1) __N(2)	☐	24
Dust, please specify (paper dust, etc.): ____________________________	__Y(1) __N(2)	☐	25
Other, please specify:	__Y(1) __N(2)	☐	26
a) _____________________________		☐	27
b) _____________________________		☐	28
c) _____________________________		☐	29
d) _____________________________		☐	30

Thinking about the last 12 months:

2.3. In the ***last 12 months***, have you experienced these symptoms while you were at work at any time?

___ Yes (1) ___No (2) ☐ 31

If YES, go on to Question 2.3.1
If NO, skip to Question 2.4

2.3.1. While you were ***away*** from work (for e.g. on weekends, off-shift, or on vacations) at any time in the ***last 12 months,*** did your symptoms seem better, worse, or the same?

Give all options at once (3)
Insert a cross (X) next to one answer only

☐ 32

a) Stay the same ______
b) Get better ______
c) Get worse ______

2.3.2. After ***returning*** to your ***work*** at any time in the ***last 12 months***, did your symptoms seem better, worse, or the same?

Give all options at once (3)
Insert a cross (X) next to one answer only

☐ 33

a) Stay the same ______
b) Get better ______
c) Get worse ______

2.4. Were you ***ever*** told by a doctor that your nose & eye symptoms were related to any job you ever had? ___ Yes (1) ___No (2) ☐ 34

If YES, go on to Question 2.4.1
If NO, skip to Question 3

2.4.1. At approximately what ***age or year*** did the doctor first diagnosed it?

Enter approximate age: _______ years old ☐☐ 35-36
OR
Enter approximate year: Year ___________ ☐☐☐☐ 37-40

2.4.2. Where were you working at time of the first symptoms?

☐ 41

____ 1. Employed in the healthcare industry
____ 2. Employed outside of the healthcare industry
____ 3. Student, please specify: ____________________________________ ☐ 42

Work-related skin symptoms

Thinking about all your working life and skin symptoms at work:

3. Does being at work ***ever*** cause you to have skin problems?

___ Yes (1) ___No (2) ☐ 43

If YES, go on to Question 3.1
If NO, END THE INTERVIEW

3.1. Since when have you been having these skin problems at work?

Date: Month ______ Year _____ ☐☐☐☐ 44-47

3.2. What do you think is causing or triggering these symptoms?

As I read each response, tell me if it applies to you

Workplace triggers			
Don't know	__Y(1) __N(2)	☐	48
Ortho-phthalaldehydes such as Cidex OPA®, Cidex OPA® C	__Y(1) __N(2)	☐	49
Glutaraldehydes such as Cidex®	__Y(1) __N(2)	☐	50
Enzymatic cleaners, such as Endozime®, Biozyme®	__Y(1) __N(2)	☐	51
Chlorhexidine containing products such as Bioscrub, D-germ, Biotane in alcohol, or Steriscrub	__Y(1) __N(2)	☐	52
Quaternary ammonium compounds such as MEDDIS®	__Y(1) __N(2)	☐	53
Bleach or chlorine, such as Domestos®, Medisure®, Biocide D®, Clorox®	__Y(1) __N(2)	☐	54
Ammonia, such as Handysan, Ammonia cleaner (cleaner all purpose)	__Y(1) __N(2)	☐	55
Other cleaning products for sterilisation/high-level disinfection of medical instruments	__Y(1) __N(2)	☐	56
Other cleaning products for cleaning fixed surfaces	__Y(1) __N(2)	☐	57
Floor strippers or waxes	__Y(1) __N(2)	☐	58
Other liquid hand soaps/sanitisers	__Y(1) __N(2)	☐	59
Adhesives, glues, or removers of surgical dressings	__Y(1) __N(2)	☐	60
Aerosolised medicines	__Y(1) __N(2)	☐	61
Gases or vapour	__Y(1) __N(2)	☐	62
Latex rubber products	__Y(1) __N(2)	☐	63
Very cold or very hot temperatures	__Y(1) __N(2)	☐	64
Dust, please specify (paper dust, etc.): ____________________________	__Y(1) __N(2)	☐	65
Other, please specify:	__Y(1) __N(2)	☐	66
a) _____________________________		☐	67
b) _____________________________		☐	68
c) _____________________________		☐	69
d) _____________________________		☐	70

Thinking about the last 12 months:

3.3. In the ***last 12 months***, have you experienced these symptoms while you were at work at any time?

___ Yes (1) ___No (2) ☐71

If YES, go on to Question 3.3.1
If NO, skip to Question 3.4

3.3.1. While you were ***away*** from work (for e.g. on weekends, off-shift, or on vacations) at any time in the ***last 12 months,*** did your symptoms seem better, worse, or the same?

Give all options at once (3)
Insert a cross (X) next to one answer only

☐72

a) Stay the same ______
b) Get better ______
c) Get worse ______

3.3.2. After ***returning*** to your ***work*** at any time in the ***last 12 months***, did your symptoms seem better, worse, or the same?

Give all options at once (3)
Insert a cross (X) next to one answer only

☐73

a) Stay the same ______
b) Get better ______
c) Get worse ______

3.4. Were you ***ever*** told by a doctor that your skin symptoms were related to any job you ever had? ___ Yes (1) ___No (2) ☐74

If YES, go on to Question 3.4.1
If NO, END THE INTERVIEW

3.4.1. At approximately what ***age or year*** did the doctor first diagnosed it?

Enter approximate age: _______ years old ☐☐75-76
OR
Enter approximate year: Year ___________ ☐☐☐☐77-80

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3.4.2. Where were you working at time of the first symptoms? ☐1

____ 1. Employed in the healthcare industry
____ 2. Employed outside of the healthcare industry ☐2
____ 3. Student, please specify: ____________________________________

THANK YOU FOR ANSWERING THE QUESTIONNAIRE

SABABU ZINAZOHUSIANA NA UGONJWA WA PUMU UNAOHUSIANA NA KAZI KWA WATUMISHI WA AFYA WAFANYAO KAZI NA KEMIKALI MBALIMBALI ZA KUFANYIA USAFI KATIKA SEKTA YA AFYA YA NCHI MBILI ZA AFRICA – 2017

DODOSO

Card 1

Namba ya utafiti ________________ ☐☐☐ 1-3

A. TAARIFA ZA MSHIRIKI

1. Jina la kwanza ____

2. Jina la ukoo ____

3. Mahali unapoishi ____
____
____

4. Namba ya kitambulisho cha kazi: ____________________________ ☐☐☐☐☐☐☐☐

5. Tarehe ya kuzaliwa: Siku _____ Mwezi ______ Mwaka ________ ☐☐☐☐☐☐ 12

6. Jinsia: ___ Mwanamme (1) ___ Mwanamke (2) ☐ 18

7. Lugha unazoongea: ☐☐ 19-20
____ English (1)
____ Kiswahili (2)
____ Nyingine (3) ________________________

8. Namba za simu:
Nyumbani _____________________________
Kazini _________________________________
Simu ya mkononi _______________________

9. Barua pepe: ____

10. Herufi za kwanza za majina ya anaehoji ______________________ ☐☐ 21-22

11. Siku ya mahojiano: Siku_______Mwezi_________Mwaka_________ ☐☐☐☐☐☐ 23

12. Hospitali: ____________________________ ☐ 29

13. Idara / Kitengo / eneo la kazi: ______________________________ ☐☐ 30-31

14.1 Siku ya shifti ya mwisho Siku____Mwezi_________Mwaka___________ ☐☐☐☐☐☐ 32

14.2. Umefanya kazi leo? ___ Ndio (1) ___Hapana (2) ☐ 38

Kama NDIO, endelea na Swali la 14.3
Kama HAPANA, nenda kwenye kipengele kinachofatia (Matatizo ya kiafya)

14.3. Shifti gani umefanya leo?
Kutoka _____________ mpaka _____________ ☐ 39

B. MATATIZO YA KIAFYA

Sauti kama za filimbi na kubanwa kifua

1. Je, ulishawahi kusikia sauti kama za filimbi kutoka kwenye kifua chako katika kipindi cha nyuma? ____ Ndio (1) ____Hapana (2) ☐40

Kama NDIO, endelea na Swali la 1.1
Kama HAPANA, nenda Swali la 2

1.1. Kama ndio, ni lini ilikuwa mara yako ya kwanza kupata hizi dalili?
Mwezi __________ Mwaka _____________ ☐☐☐☐41-44

1.2. Je, umewahi kusikia sauti kama za filimbi kutoka kwenye kifua chako wakati wowote ule katika kipindi cha ***miezi 12 iliyopita?*** ____ Ndio (1) ____Hapana (2) ☐45

Kama NDIO, endelea na Swali la 1.2.1
Kama HAPANA, nenda Swali la 2

1.2.1. Umeshawahi kupata shida kupumua wakati ukiwa na hizo sauti kama za filimbi? ____ Ndio (1) ____Hapana (2) ☐46

1.2.2. Umeshawahi kuwa na hizi sauti kama za filimbi wakati ukiwa hauna mafua?
____ Ndio (1) ____Hapana (2) ☐47

2. Umeshawahi kuamka usingizini kwa sababu ya kubanwa kifua wakati wowote ule katika kipindi cha ***miezi 12 iliyopita?*** ____ Ndio (1) ____Hapana (2) ☐48

Kupumua kwa shida

3. Umeshawahi kupata shida ya kupumua wakati wowote ule katika kipindi cha ***miezi 12 iliyopita?*** ____ Ndio (1) ____Hapana (2) ☐49

4. Umeshawahi kupata shida ya kupumua muda wa mchana wakati ukiwa umepumzika katika kipindi cha ***miezi 12 iliyopita?***
____ Ndio (1) ____Hapana (2) ☐50

5. Umeshawahi kupata shida ya kupumua kwasababu ya kukimbia au mazoezi wakati wowote ule katika kipindi cha ***miezi 12 iliyopita?***
____ Ndio (1) ____Hapana (2) ☐51

6. Umeshawahi kuamka usingizini kwasababu ya shida ya kupumua wakati wowote ule katika kipindi cha ***miezi 12 iliyopita?*** ____ Ndio (1) ____Hapana (2) ☐52

Kikohozi na makohozi toka kifuani

7. Umeshawahi kuamka usingizini kwa sababu ya kikohozi wakati wowote ule katika kipindi cha ***miezi 12 iliyopita?*** ____ Ndio (1) ____Hapana (2) ☐53

8. Kwa kawaida huwa unakohoa asubuhi na mapema?
____ Ndio (1) ____Hapana (2) ☐54

9. Kwa kawaida huwa unakohoa wakati wa mchana au usiku?

____ Ndio (1) ____Hapana (2) 55

Kama NDIO, endelea na Swali la 9.1
Kama HAPANA, nenda Swali la 10

9.1. Huwa unakohoa kama hivi mchana au usiku kwa siku nyingi zaidi mpaka kufikia ***miezi 3 au zaidi*** kwa kila mwaka katika kipindi cha ***miaka hii miwili iliyopita?***

____ Ndio (1) ____Hapana (2) 56

10. Kwa kawaida huwa unapata makohozi toka kifuani kwako ***asubuhi*** na mapema?

____ Ndio (1) ____Hapana (2) 57

11. Kwa kawaida huwa unapata makohozi toka kifuani kwako wakati wa mchana au usiku? ____ Ndio (1) ____Hapana (2) 58

Kama NDIO, endelea na Swali la 11.1
Kama HAPANA, nenda Swali la 12

11.1. Huwa unapata makohozi kama hivi mchana au usiku kwa siku nyingi zaidi mpaka kufikia ***miezi 3 au zaidi*** kwa kila mwaka katika kipindi cha ***miaka hii miwili iliyopita?*** ____ Ndio (1) ____Hapana (2) 59

<u>Upumuaji</u>

12. Umewahi kuwa na shida na upumuaji wako?

____ Ndio (1) ____Hapana (2) 60

Kama NDIO, endelea na Swali la 12.1
Kama HAPANA, nenda Swali la 13

12.1. Shida hii ya kupumua:

Toa majibu yote matatu kwa wakati mmoja
Weka alama ya (X) mbele ya jibu sahihi

61

a) Inakuwepo muda wote, kwahiyo upumuaji wako unakuwa hauko sawa hata mara moja? ______

b) Inajirudiarudia, lakini kuna kipindi inakuwa haipo kabisa? ______

c) Inatokea mara chache sana? ______

13. Una elemavu wa kushindwa kutembea kwa sababu nyingine isipokuwa ugonjwa wa moyo au mapafu? ____ Ndio (1) ____Hapana (2) 62

Kama NDIO, itaje ni sababu gani ____________________________________ 63
na endelea na kipengele kinachofuata (Ugonjwa wa pumu)
Kama HAPANA, endelea na Swali la 13.1

13.1. Unapata shida kupumua ukiwa unatembea kwa ***haraka*** katika sehemu ***tambarare*** isiyokuwa na kilima AU wakati ukitembea ***kupanda kilima kidogo?***

____ Ndio (1) ____Hapana (2) 64

Kama NDIO, endelea na Swali la 13.1.1
Kama HAPANA, nenda katika kipengele kinachofuata (Ugonjwa wa pumu)

13.1.1. Unapata shida kupumua ukiwa unatembea na watu wa umri wako katika sehemu tambarare?

____ Ndio (1) ____Hapana (2) ☐65

13.1.2. Huwa inabidi usimame kwa sababu ya shida ya kupumua ukiwa unatembea kwa kasi yako mwenyewe katika sehemu tambarare?

____ Ndio (1) ____Hapana (2) ☐66

Ugonjwa wa pumu

1. Umeshawahi kuwa na shida ya kupumua wakati ukiwa umepumzika na muda huo huo ukawa na sauti kama za filimbi kutoka kifuani kwako?

____ Ndio (1) ____Hapana (2) ☐67

2. Umeshawahi kuumwa ***ugonjwa wa pumu?***

____ Ndio (1) ____Hapana (2) ☐68

3. Umeshawahi kupata ***shambulizi la pumu?***

____ Ndio (1) ____Hapana (2) ☐69

"Shambulizi la pumu" ni wakati dalili zako za pumu (sauti kama za filimbi, shida ya kupumua, kubanwa kifua au kikohozi) zinakuwa mbaya kuliko kawaida yake

Kama jibu ni NDIO kwa aidha swali la 1,2 au 3, endelea na Swali la 4
Kama jibu ni HAPANA kwa swali 1,2 na 3, nenda kwenye kipengele kinachofuata (Historia ya matibabu)

4. Je, ugonjwa wako wa pumu umeshawahi kuthibitishwa na daktari?

____ Ndio (1) ____Hapana (2) ☐70

5. Ulikuwa na umri gani wakati ulivyoambiwa na daktari kwamba una pumu?

Toa majibu yote matatu kwa wakati mmoja
Weka alama ya (X) mbele ya jibu moja tu

☐71

a) Kabla hujafikisha miaka 17 ____
b) Ukiwa na miaka 17 au zaidi ____
c) Mara zote ____

6. Umepata shambulizi la pumu katika kipindi cha ***miezi 12 iliyopita?***

____ Ndio (1) ____Hapana (2) ☐72

Kama NDIO, endelea na Swali la 6.1
Kama HAPANA, nenda Swali la 7

6.1. Umepata mashambulizi ya pumu mangapi katika kipindi cha ***miezi 12 iliyopita?***

Andika kadirio la namba: *mashambulizi* ________ ☐☐73-74

6.2. Umepata mashambulizi ya pumu mangapi katika kipindi cha ***miezi 3 iliyopita?***

Andika kadirio la namba: *mashambulizi* ________ ☐☐75-76

7. Ulikuwa una umri gani ulivyopata shambulizi lako la pumu la kwanza kabisa? Card 2

Andika kadirio la umri: Miaka _______ ☐☐1-2
AU
Andika kadirio la mwaka: Mwaka ___________ ☐☐☐☐3-6

8. Ulikuwa na umri gani ulivyopata shambulizi lako la pumu la hivi karibuni?

Andika kadirio la umri: Miaka _______ 7-8

AU

Andika kadirio la mwaka: Mwaka ___________ 9-12

9. Ulikuwa umeajiriwa wakati ulivyopata shambulizi lako la pumu la kwanza kabisa?

____ Ndio (1) ____Hapana (2) 13

Kama NDIO, endelea na Swali la 9.1
Kama HAPANA, nenda Swali la 10

Wakati ulivyopata shambulizi lako la pumu la kwanza kabisa:

9.1. Ni kazi gani ulikuwa unafanya?

Cheo cha kazi: ____ 14-15

9.2. Ulikuwa unafanya shughuli gani katika kazi hii?

Shughuli: ____ 16-17

9.3. Ni aina gani ya kampuni uliyokuwa unafanya kazi?

Sekta: ____ 18-19

10. Baada ya pumu kuanza, kuna kipindi ulikuwa haupati dalili za pumu?

____ Ndio (1) ____Hapana (2) 20

Usirekodi kama mshiriki alikuwa anatumia dawa za pumu katika kipindi hicho

Kama NDIO, endelea na Swali la 10.1
Kama HAPANA, nenda Swali la 11

10.1. Dalili zako za pumu zilipotea ukiwa una umri gani?

Andika kadirio la umri: Miaka _______ 21-22

AU

Andika kadirio la mwaka: Mwaka ___________ 23-26

10.2. Dalili zako za pumu zilirudi tena? ____ Ndio (1) ____Hapana (2) 27

Kama NDIO, endelea na Swali la 10.2.1
Kama HAPANA, nenda Swali la 11

10.2.1. Dalili zako za pumu zilirudi ukiwa na umri gani?

Andika kadirio la umri: Miaka _______ 28-29

AU

Andika kadirio la mwaka: Mwaka ___________ 30-33

10.2.2. Ulikuwa umeajiriwa wakati dalili zako za pumu zilivyorudi?

____ Ndio (1) ____Hapana (2) 34

Kama NDIO, endelea na Swali la 10.2.2.1
Kama HAPANA, nenda Swali la 11

Wakati dalili zako za pumu zilivyorudi:
10.2.2.1. NI kazi gani ulikuwa unafanya?
Cheo cha kazi: ____ ☐☐35-36

10.2.2.2. Ulikuwa unafanya shughuli gani katika kazi hii?
Shughuli: ____ ☐☐37-38

10.2.2.3. Ni aina gani ya kampuni uliyokuwa unafanya kazi?
Sekta: ____ ☐☐39-40

11. Ni msimu gani wa mwaka huwa unapata mashambulizi ya pumu?

11.1. Msimu wa baridi	___ Ndio (1)	___ Hapana (2)	___ Sijui (3)	☐41
11.2. Spring	___ Ndio (1)	___ Hapana (2)	___ Sijui (3)	☐42
11.3. Msimu wa joto	___ Ndio (1)	___ Hapana (2)	___ Sijui (3)	☐43
11.4. Autumn	___ Ndio (1)	___ Hapana (2)	___ Sijui (3)	☐44

12. Dalili zako za pumu zinasababishwa au zinakuwa mbaya zaidi kwa sababu ya yoyote yafuatayo:
Jibu maswali yote

12.1. Ukiwa karibu na wanyama	____ Ndio (1)	____Hapana (2)	☐45
12.2. Majani au maua	____ Ndio (1)	____Hapana (2)	☐46
12.3. Zoezi kubwa	____ Ndio (1)	____Hapana (2)	☐47
12.4. Kupumua hewa yenye baridi	____ Ndio (1)	____Hapana (2)	☐48
12.5. Moshi wa tumbaku	____ Ndio (1)	____Hapana (2)	☐49
12.6. Mabadiliko ya hali ya hewa	____ Ndio (1)	____Hapana (2)	☐50
12.7. Kemikali za kufanyia usafi nyumbani	____ Ndio (1)	____Hapana (2)	☐51
12.8. Manukato	____ Ndio (1)	____Hapana (2)	☐52

13. Ilishawahi kukulazimu kukosa kwenda kazini kwa sababu ya pumu katika kipindi cha ***miezi 12 iliyopita?*** ____ Ndio (1) ____Hapana (2) ☐53

Kama NDIO, endelea na Swali la 13.1
Kama HAPANA, nenda Swali la 14

13.1. Ni siku ngapi za kazi ilikulazimu kuzikosa kwa sababu ya pumu katika kipindi cha ***miezi 12 iliyopita?***
Andika kadirio la namba: Siku _______ ☐☐☐54-56

14. Katika kipindi cha ***miezi 12 iliyopita,*** uliwahi kwenda kazini ingawa dalili zako za pumu zilikuwa mbaya kabisa? ____ Ndio (1) ____Hapana (2) ☐57

Kama NDIO, endelea na Swali la 14.1
Kama HAPANA, nenda Swali la 15

14.1 Katika kipindi cha ***miezi 12 iliyopita,*** ni siku ngapi uliienda kazini ingawa dalili zako za pumu zilikuwa mbaya kabisa?

Andika kadirio la namba: Siku _______ ☐☐☐58-60

15. Ulishawahi kulazwa hospitalini usiku kucha kwa sababu ya pumu?
____ Ndio (1) ____Hapana (2) ☐61

Kama NDIO, endelea na Swali la 15.1
Kama HAPANA, nenda Swali la 16

15.1. Katika kipindi cha ***miezi 12 iliyopita,*** umewahi kulazwa hospitalini usiku kucha kwa sababu ya pumu? ____ Ndio (1) ____Hapana (2) ☐62

16. Katika kipindi cha ***miezi 12 iliyopita,*** umewahi kupata matibabu ya dharura kwa sababu ya shambulizi la pumu aidha kwenye ofisi ya daktari, au kituo cha huduma ya haraka, au idara ya magonjwa ya dharura na majeruhi?
____ Ndio (1) ____Hapana (2) ☐63

Usihesabu zile tarehe za kawaida za kupangiwa kuja kiliniki
Kama NDIO, endelea na Swali la 16.1
Kama HAPANA, nenda Swali la 17

16.1. Katika kipindi cha ***miezi 12 iliyopita,*** ni mara ngapi umepata matibabu ya dharura kwa sababu ya shambulizi la pumu aidha kwenye ofisi ya daktari, au kituo cha huduma ya haraka, au idara ya magonjwa ya dharura na majeruhi?

Usihesabu zile tarehe za kawaida za kupangiwa kuja kiliniki Mara _______ ☐☐64-65

17. Unatumia dawa zozote zile za pumu au matatizo ya kupumua, kama dawa za kuvuta (inhalers), nebulaiza, dawa za maji za kunywa au vidonge?
____ Ndio (1) ____Hapana (2) ☐66

Kama NDIO, endelea na Swali la 17.1, huku ukiwa unaonyesha mifano ya dawa
Kama HAPANA, nenda Swali la 18

17.1. Ni dawa gani hizo?

____ ☐67
____ ☐68
____ ☐69

17.2. Utumia dawa hizi kila siku hata wakati ukiwa hauna shida ya kupumua?
____ Ndio (1) ____Hapana (2) ☐70

17.3. Katika kipindi cha ***miezi 12 iliyopita*** , umetumia fast-acting or rescue <u>bronchodilators</u>, kama Asthalin au Ventolin, kwa sababu ya pumu?
____ Ndio (1) ____Hapana (2) ☐71

Kama NDIO, endelea na Swali la 17.3.1
Kama HAPANA, nenda Swali la 18

17.3.1. Katika kipindi cha ***miezi 12 iliyopita,*** kuna wakati uliongeza matumizi ya fast-acting or rescue <u>bronchodilators</u> kwa muda mfupi, kama kwa siku 2 had wiki 2 hivi?
____ Ndio (1) ____Hapana (2) ☐72

17.4. Katika kipindi cha ***miezi 12 iliyopita*** , umetumia dawa za steroids za kuvuta, kama Budecort, Ibicar au Alvesco, kwa sababu ya pumu?

____ Ndio (1) ____Hapana (2) ☐73

Kama NDIO, endelea na Swali la 17.4.1
Kama HAPANA, nenda Swali la 17.5

17.4.1. Katika kipindi cha ***miezi 12 iliyopita,*** kuna wakati uliongeza matumizi ya dawa za steroids za kuvuta kwa muda mfupi, kama kwa siku 2 hadi wiki 2 hivi?

____ Ndio (1) ____Hapana (2) ☐74

17.5. Katika kipindi cha ***miezi 12 iliyopita,*** umetumia dawa za steroids za kumeza, kama Prednisone, kwa sababu ya pumu?

____ Ndio (1) ____Hapana (2) ☐75

Kama NDIO, endelea na Swali la 17.5.1
Kama HAPANA, nenda Swali la 18

17.5.1. Katika kipindi cha ***miezi 12 iliyopita,*** kuna wakati uliongeza matumizi ya dawa za steroids za kumeza kwa muda mfupi, kama kwa siku 2 hadi wiki 2 hivi?

____ Ndio (1) ____Hapana (2) ☐76

Current asthma control test

Sasa nitakuuliza maswali kuhusu hali ya pumu yako katika kipindi cha
wiki 4 zilizopita:

18. Katika kipindi cha ***wiki 4 zilizopita,*** ni muda kiasi gani pumu yako imekuzuia kufanya kazi ukiwa kazini au nyumbani? ☐77

______ Mara zote (1)
______ Mara nyingi (2)
______ Wakati fulani (3)
______ Mara chache tu (4)
______ Hata mara moja (5)

19. Katika kipindi cha ***wiki 4 zilizopita,*** ni mara ngapi umepata shida kupumua? ☐78

______ Zaidi ya mara moja kwa siku (1)
______ Mara moja kwa siku (2)
______ Mara 3 hadi 6 kwa wiki (3)
______ Mara moja au mbili kwa wiki (4)
______ Hata mara moja (5)

20. Katika kipindi cha ***wiki 4 zilizopita,*** ni mara ngapi dalili zako za pumu (sauti kama za filimbi, kukohoa, kupumua kwa shida, kubanwa kifua au maumivu kifuani) zimekuamsha usiku au asubuhi ya mapema kuliko kawaida? ☐79

______ Usiku 4 au zaidi kwa wiki (1)
______ Usiku 2 hadi 3 kwa wiki (2)
______ Mara moja kwa wiki (3)
______ Mara moja au mbili (4)
______ Hata mara moja (5)

21. Katika kipindi cha ***wiki 4 zilizopita,*** ni mara ngapi umetumia rescue inhaler yako au dawa zako za nebulaiza (kama Asthalin au Ventolin)? ☐ 80

______ Mara 3 au zaidi kwa siku (1)
______ Mara 1 au 2 kwa siku (2)
______ Mara 2 au 3 kwa wiki (3)
______ Mara 1 kwa wiki au chini ya hapo (4)
______ Hata mara moja (5)

Card 3

23. Ni kwa kiwango gani unaweza kusema mwili wako umeihimili pumu yako katika kipindi cha ***wiki 4 zilizopita?*** ☐ 1

______ Haujaihimili kabisa (1)
______ Haujaihimili vizuri (2)
______ Umeihimili kiasi fulani (3)
______ Umeihimili vizuri (4)
______ Umeihimili vizuri kabisa (5)

Historia ya matibabu

1. Ulishawahi kutibiwa kwa ajili ya haya yafuatayo?

Jibu maswali yote

1.1. Chronic bronchitis ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 2

1.2. Kifua kikuu (TB) ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 3

1.3. Maambukizi ya kifuani ya ***mara kwa mara*** wakati ukiwa mdogo
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 4

Matatizo ya pua na macho

1. Umeshawahi kuwa na "allergies" za pua na macho kama "hay fever"?
____ Ndio (1) ____Hapana (2) ☐ 5

Kama NDIO, endelea na Swali la 1.1. Jibu maswali yote
Kama HAPANA, nenda Swali la 1.4

1.1. Ulikuwa na umri gani wakati ulivyoanza kupata hizi dalili kwa mara ya kwanza?

Andika kadirio la umri: Miaka _______ ☐☐ 6-7
AU
Andika kadirio la mwaka: Mwaka ___________ ☐☐☐☐ 8-11

1.2. Katika kipindi cha ***miezi 12 iliyopita,*** je umepata dalili zifuatazo kwa mara mbili au zaidi:

1.2.1. Kupiga chafya au pua kuwasha au kutokwa na makamasi wakati ukiwa hauna mafua? ____ Ndio (1) ____Hapana (2) ☐ 12

1.2.2. Macho kuwa mekundu au kuwasha au kutoa machozi
____ Ndio (1) ____Hapana (2) ☐ 13

1.2.3. Kuna kipindi fulani cha mwaka ambapo huwa unapata dalili hizi za pua na macho? ____ Ndio (1) ____Hapana (2) ☐ 14

1.2.3.1. Kama NDIO, je ni kipindi gani huwa kibaya zaidi?

Toa majibu yote manne kwa wakati mmoja
Weka alama ya (X) mbele ya jibu moja tu

1.2.3.1.1. Kipindi cha baridi ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 15

1.2.3.1.2. Spring ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 16

1.2.3.1.3. Kipindi cha joto ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 17

1.2.3.1.4. Autumn ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 18

1.3. Unatumia dawa zozote kwa ajili ya dalili zako za pua au macho, kama dawa za kupulizia puani, za matone puani, vidonge au sindano?
____ Ndio (1) ____Hapana (2) ☐ 19

Kama NDIO, endelea na Swali la 1.3.1
Kama HAPANA, nenda Swali la 1.4

Onyesha karatasi yenye aina mbali mbali za dawa za "allergy"
(N.B. mshiriki anaweza kukuonyesha dawa zake)

1.3.1. Ni dawa gani hizo?

______________________________ ☐ 20
______________________________ ☐ 21
______________________________ ☐ 22

1.4. Ulikuwa na "hay fever" (pua kuwasha, kutokwa makamasi, macho kuwasha au kutoa machozi) wakati ukiwa mtoto?
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 23

Matatizo ya ngozi

1. Ushawahi kuwa na tatizo lolote la ngozi aidha ukiwa nyumbani au kazini?
____ Ndio (1) ____Hapana (2) ☐ 24

Kama NDIO, endelea na Swali la 1.1
Kama HAPANA, nenda Swali la 1.6

1.1. Kama NDIO, ilikuwa ni tatizo gani?

______________________________ ☐☐ 25-26
____

1.2. Ulikuwa na umri gani wakati ulivyopata hilo tatizo la ngozi kwa mara ya kwanza?

Andika kadirio la umri: Miaka _______ ☐☐ 27-28
AU
Andika kadirio la mwaka: Mwaka ___________ ☐☐☐☐ 29-32

1.3. Katika kipindi cha ***miezi 12 iliyopita,*** umepata tatizo la ngozi ambalo limetokea ***mara 2 au zaidi?*** ____ Ndio (1) ____Hapana (2) ☐33

Kama NDIO, ni tatizo gani ulikuwa nalo kati ya haya yafuatayo?

Uliza kila swali hapa chini na uzungushie jibu sahihi

	Mikono kuanzia kwenye viwiko	**Mwili mzima**	
1.3.1. Kuwashwa ngozi	___Ndio(1) ___Hapana(2)	___Ndio(1) ___Hapana(2)	☐34 ☐35
1.3.2. Hives ("bommels")	___Ndio(1) ___Hapana(2)	___Ndio(1) ___Hapana(2)	☐36 ☐37
1.3.3. Ngozi kavu/magamba	___Ndio(1) ___Hapana(2)	___Ndio(1) ___Hapana(2)	☐38 ☐39
1.3.4 Ngozi kuwa nyekundu	___Ndio(1) ___Hapana(2)	___Ndio(1) ___Hapana(2)	☐40 ☐41
1.3.5. Malengelenge/maji maji kwenye ngozi	___Ndio(1) ___Hapana(2)	___Ndio(1) ___Hapana(2)	☐42 ☐43
1.3.6. Burning skin	___Ndio(1) ___Hapana(2)	___Ndio(1) ___Hapana(2)	☐44 ☐45
1.3.7. Upele ndani ya lisaa limoja la kukutana na mpira (latex)	___Ndio(1) ___Hapana(2)	___Ndio(1) ___Hapana(2)	☐46 ☐47
1.3.8. Mengine, yataje:____________	___Ndio(1) ___Hapana(2)	___Ndio(1) ___Hapana(2)	☐48 ☐49

____

____ ☐50

1.4. Ulipata matatizo ya kifua baada ya kupata matatizo haya ya ngozi?

____ Ndio (1) ____Hapana (2) ☐51

1.5. Unatumia dawa zozote kwa matatizo yako ya ngozi kama creams au ointments?

____ Ndio (1) ____Hapana (2) ☐52

Kama NDIO, endelea na Swali la 1.5.1

Kama HAPANA, nenda Swali la 1.6

1.5.1. Ni dawa gani hizo?

____ ☐53

____ ☐54

____ ☐55

1.6. Umeshawahi kuumia kwenye vidole au mikono wakati ukiwa unafanya kazi katika hospitali hii? ____ Ndio (1) ____Hapana (2) 56

1.7. Unaosha mikono yako mara ngapi kwa siku?

Andika kadirio la namba: Mara ________ kwa siku 57-58

1.8. Ulikuwa na pumu ya ngozi ulivyokuwa mtoto?
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) 59

Matatizo mengine ya "allergy"

1. Unapata "allergy" uking'atwa na wadudu?
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) 60

Kama NDIO, endelea na Swali la 1.1
Kama HAPANA, nenda Swali la 2

1.1. Ni madhara gani unapata uking'atwa na wadudu?

1.1.1. Shida kupumua, kuzirai, homa?
____ Ndio (1) ____Hapana (2) 61

1.1.2. Wekundu, kuwashwa au kuvimba pale ulipong'watwa?
____ Ndio (1) ____Hapana (2) 62

1.1.3. Mengine: ________________________________ 63

2. Umeshawahi kupata shida kupumua baada ya kumeza dawa au sindano ambayo ulikuwa hauna kabla ya hapo?
____ Ndio (1) ____Hapana (2) 64

Kama NDIO, endelea na Swali la 2.1
Kama HAPANA, nenda Swali la 3

2.1. Ni dawa gani hizo?
____ 65
____ 66

3. Umeshawahi kupata dalili zozote zile zinazohusiana na vitu venye "latex" kama gloves au catheters, n.k.? ___ Yes (1) ___No (2) ☐ 67

Kama NDIO, endelea na Swali la 3.1
Kama HAPANA, nenda Swali la 4

3.1. Kama NDIO, ni dalili gani ulipata?

3.1.1. Kuwashwa ngozi ____ Ndio (1) ____Hapana (2) ☐ 68

3.1.2. Hives ("bommels") ____ Ndio (1) ____Hapana (2) ☐ 69

3.1.3. Malengelenge/maji maji kwenye ngozi ____ Ndio (1) ____Hapana (2) ☐ 70

3.1.4. Kupumua kwa shida/kifua kubana/sauti kama za filimbi ____ Ndio (1) ____Hapana (2) ☐ 71

3.1.5. Kupiga chafya, pua kuwasha, kuziba au kutokwa na makamasi ____ Ndio (1) ____Hapana (2) ☐ 72

3.1.6. Macho kuwa mekundu, kuwasha au kutokwa na machozi ____ Ndio (1) ____Hapana (2) ☐ 73

3.1.7. Kuzimia ____ Ndio (1) ____Hapana (2) ☐ 74

3.2. Ushawahi kuambiwa na wataalam kwamba una allergy ya latex? ____ Ndio (1) ____Hapana (2) ☐ 75

Kama NDIO, endelea na Swali la 3.2.1
Kama HAPANA, nenda Swali la 4

3.2.1.Kama NDIO, ilikuwa ni lini hiyo? Card 4

Andika kadirio la umri: Miaka _______ ☐☐ 1-2

AU

Andika kadirio la mwaka: Mwaka ___________ ☐☐☐☐ 3-6

4. Umeshawahi kuwa na ugonjwa, tatizo la afya au allergy iliyosababishwa na kula chakula/tunda fulani?

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐7

Kama NDIO, endelea na Swali la 4.1
Kama HAPANA, nenda Swali la 5

4.1 Ilikuwa ni chakula/tunda aina gani?

____ ☐☐8-9

4.1. Ugonjwa huu au tatizo hili la afya lilikuwa ni pamoja na:

4.1.1. Kuwashwa ngozi au upele	____ Ndio (1)	____Hapana (2)	☐10
4.1.2. Kuharisha au kutapika	____ Ndio (1)	____Hapana (2)	☐11
4.1.3. Pua kuziba au kutokwa na makamasi	____ Ndio (1)	____Hapana (2)	☐12
4.1.4. Kichwa kuuma sana	____ Ndio (1)	____Hapana (2)	☐13
4.1.5. Kupumua kwa shida/kifua kubana/sauti kama za filimbi	____ Ndio (1)	____Hapana (2)	☐14
4.1.6. Mengine:________________________________			☐15
4.2. Hicho chakula kilikuwa na ni cha kopo au cha kuhifadhiwa?	____ Ndio (1)	____Hapana (2)	☐16
4.3. Unapata matatizo haya ukinywa vinjwaji vyenye gesi kama soda?	____ Ndio (1)	____Hapana (2)	☐17
5. Umeshawahi kufanyiwa upasuaji wa mwili au wa meno ambao ilibidi uingie chumba cha upasuaji (theatre)?	____ Ndio (1)	____Hapana (2)	☐18

6. Ukiwa karibu na wanyama (kama paka, mbwa au farasi),
AU karibu na miti, majani au maua au kukiwa na poleni nyingi,
AU karibu na mito, mablanketi, au katika sehemu yenye vumbi nyumbani, huwa

6.1. Unaanza kukohoa?	____ Ndio (1)	____Hapana (2)	☐19
6.2. Unaanza kupata sauti kama za filimbi?	____ Ndio (1)	____Hapana (2)	☐20
6.3. Unabanwa kifua?	____ Ndio (1)	____Hapana (2)	☐21
6.4. Unaanza kupumua kwa shida?	____ Ndio (1)	____Hapana (2)	☐22
6.5. Unapiga chafya/pua kuziba/kutoa makamasi?	____ Ndio (1)	____Hapana (2)	☐23
6.6. Macho yanawasha au kutoa machozi?	____ Ndio (1)	____Hapana (2)	☐24
6.7. Ngozi inawasha au unapatwa na upele?	____ Ndio (1)	____Hapana (2)	☐25

C. HISTORIA YA FAMILIA

1. Kuna ndugu wa damu katika familia yenu ambae alishakuwa/ana allergy yoyote ile?

Hii haimaanishi undugu wa kuoana
Kama historia ya familia haijulikani, jaza jibu la 'SIJUI' na usijaze jedwali hapo chini. Nenda kipengele kinachofuata (Uvutaji Sigara)

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 26

Kama NDIO, jaza jedwali hapa chini. Weka alama ya (X) panapotakiwa kwenye kila swali
Kama HAPANA, nenda kipengele kinachofuata (Uvutaji Sigara)

Aina ya allergy:	Mzazi	Kaka/dada	Mtoto	
1.1. Hay fever	1	2	3	☐☐☐ 27-29
1.2. Pumu ya ngozi	1	2	3	☐☐☐ 30-32
1.3. Pumu	1	2	3	☐☐☐ 33-35
1.4. Ya chakula (e.g. tunda, samaki, viungo)	1	2	3	☐☐☐ 36-38
1.5. Allergy nyingine,	1	2	3	☐☐☐ 39-41

Zitaje: ________________________________

D. UVUTAJI SIGARA

1. Umeshawahi kuvuta tumbaku (sigara au kiko) kwa kipindi kinachofika mwaka mmoja?

'NDIO' ina maana angalau pakiti 20 za sigara au gramu 360 za tumbaku maishani au angalau sigara moja kwa siku kwa mwaka mzima

____ Ndio (1) ____Hapana (2) ☐ 42

Kama NDIO, endelea na Swali la 1.1
Kama HAPANA, nenda Swali la 2

1.1. Ulikuwa na umri gani wakati umeanza kuvuta ***mara kwa mara?***

Andika kadirio la umri: Miaka _______ ☐☐ 43-44

AU

Andika kadirio la mwaka: Mwaka ___________ ☐☐☐☐ 45-48

1.2. Unavuta siku hizi?

'NDIO' ina maana kavuta tumbaku katika kipindi cha mwezi huu mmoja uliopita au karibu zaidi

____ Ndio (1) ____Hapana (2) ☐ 49

Kama NDIO, endelea na Swali la 1.2.1
Kama HAPANA, nenda Swali la 1.3

1.2.1. Kwa wastani, unavuta kiasi gani?

1.2.1.1. Sigara kwa siku __________ ☐☐ 50-51

1.2.1.2. Kiko (gramu kwa wiki) __________ ☐☐☐ 52-54

1.3. Ulishawahi kuacha kuvuta kabisa? ____ Ndio (1) ____Hapana (2) ☐ 55

Kama NDIO, endelea na Swali la 1.3.1
Kama HAPANA, nenda Swali la 1.4

1.3.1. Ulikuwa na umri gani ulivyoacha kuvuta kabisa?

Andika kadirio la umri: Miaka _______ ☐☐ 56-57

AU

Andika kadirio la mwaka: Mwaka ___________ ☐☐☐☐ 58-61

1.4. Ni miaka mingapi kwa ujumla uliyovuta tumbaku?
(Usihesabu ile miaka ambayo mshiriki alikuwa ameacha kuvuta kabla hajaanza tena)

Miaka ____ ____ ☐☐ 62-63

1.5. Kwa wastani katika kipindi chote ulichovuta, umevuta kiasi gani?

1.5.1. Sigara kwa siku ___ ___ ☐☐ 64-65

1.5.2. Kiko (gramu kwa wiki) ___ ___ ___ ☐☐☐ 66-68

1.6. Ulimeza/unameza moshi ukivuta? ____ Ndio (1) ____Hapana (2) ☐ 69

2. Umekuwa ukipata moshi wa tumbaku ***mara kwa mara*** kutoka kwa watu wengine wanaovuta sigara au kiko katika kipindi cha **miezi 12 iliyopita?**

____ Ndio (1) ____Hapana (2) ☐ 70

'Mara kwa mara' ina maana siku nyingi zaidi

E. ELIMU NA MAFUNZO YA AFYA NA USALAMA MAHALA PA KAZI

1. Unajua madhara yoyote yanayosababishwa na kemikali unazofanya nazo kazi?
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐71

Kama NDIO, endelea na Swali la 1.1
Kama HAPANA, nenda Swali la 2

1.1. Kama NDIO, ni madhara gani hayo? ___________________________________ ☐☐72-73
____
____

2. Unajua hatua zozote zile za kuilinda afya yako na afya za watu wengine makazini?
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐74

Kama NDIO, endelea na Swali la 2.1
Kama HAPANA, nenda Swali la 3

2.1. Kama NDIO, ni hatua gani hizo? ___________________________________ ☐☐75-76
____ ☐☐77-78
____

3. Kuna hatua zozote zile zilizopo hapa hospitalini za kulinda afya zenu?
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐79

Kama NDIO, endelea na Swali la 3.1
Kama HAPANA, nenda Swali la 4 Card 5

3.1. Kama NDIO, ni hatua gani hizo? ___________________________________ ☐☐1-2
____ ☐☐3-4
____

3.2. Utazipa kiwango gani hatua hizi za kulinda afya zilizopo hapa, kati ya 1 - 5? ☐5
_____ 3.2.1. Hazitoshi kabisa (1)
_____ 3.2.2. Hazitoshi (2)
_____ 3.2.3. Zinatosha (wastani) (3)
_____ 3.2.4. Nzuri (4)
_____ 3.2.5. Nzuri sana (5)

4. Umepata mafunzo yoyote kuhusu afya na usalama wa kufanya kazi na kemikali hospitalini? ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐6

Kama NDIO, endelea na Swali la 4.1
Kama HAPANA, nenda kipengele kinachofuata (Mazingira ya Nyumbani)

4.1. Ulipata mafunzo haya mara tu ulipoanza kazi?
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐7

4.2. Ni mara ngapi kwa mwaka unapata mafunzo kuhusu afya na usalama wa kufanya kazi na kemikali? ☐8

_____ 4.2.1. Chini ya mara moja kwa mwaka
_____ 4.2.2. Mara moja kwa mwaka
_____ 4.2.3. Zaidi ya mara moja kwa mwaka

4.3 Utayapa kiwango gani mafunzo haya ya afya na usalama uliyoyapata, kati ya 1-5? ☐9

_____ 4.3.1. Hayatoshi kabisa (1)
_____ 4.3.2. Hayatoshi (2)
_____ 4.3.3. Yanatosha (wastani) (3)
_____ 4.3.4. Mazuri (4)
_____ 4.3.5. Mazuri sana (5)

F. MAZINGIRA YA NYUMBANI

Maswali yanayofuata yanahusu nyumba unayoishi sasa

1. Katika kipindi cha ***miezi 12 iliyopita,*** umeona yoyote yafuatayo nyumbani kwako?

1.1. Maji kuvuja au uharibifu wa maji ndani ya nyumba kama kwenye kuta, sakafu au dari? ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 10

1.2. Fangasi zinazoonekana ndani ya nyumba (sio kwenye chakula) kama kwenye kuta, sakafu, au dari? ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 11

1.3. Harufu ya fangasi (sio kwenye chakula)? ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 12

2. Katika kipindi cha ***miezi 12 iliyopita,*** kumekuwa na matengenezo au ujenzi wowote nyumbani kwako? ____ Ndio (1) ____Hapana (2) ☐ 13

3. Katika kipindi cha ***miezi 12 iliyopita,*** ni mara ngapi wewe mwenyewe umefanya usafi nyumbani kwako?

Sijafanya	< siku 1 /wiki	Siku 1-2 /wiki	Siku 3-4 / wiki	Siku 5-7 / wiki
(a)	(b)	(c)	(d)	(e)

☐ 14

Kama 'SIJAFANYA': nenda kipengele kinachofuata (Ajali za kemikali kumwagika au gesi kutoka)
Kwa majibu mengine isipokuwa 'SIJAFANYA': nenda Swali la 4

4. Katika kipindi cha ***miezi 12 iliyopita,*** ni mara ngapi kwa wiki umetumia kemikali hizi kufanyia usafi nyumbani kwako?

Weka alama (X) kwenye jibu sahihi kwa kila kemikali

	Sijatumia	< Siku 1 /wiki	Siku 1-2 /wiki	Siku 3-4 / wiki	Siku 5-7 / wiki	
4.1. Bleach kama Domestos, Jik	1	2	3	4	5	☐ 15
4.2. Kemikali zenye ammonia kama Handy Andy	1	2	3	4	5	☐ 16
4.3. Kemikali za kuoshea madirisha kama Windolene	1	2	3	4	5	☐ 17
4.4. Air freshener ya kupuliza kama Glade	1	2	3	4	5	☐ 18
4.5. Kemikali yoyote ya kufanyia usafi ya kupuliza	1	2	3	4	5	☐ 19

G. AJALI ZA KEMIKALI KUMWAGIKA AU GESI KUTOKA

1. Umeshawahi kupata au kukaribia kupata ajali ya kemikali kumwagika au gesi kutoka ukiwa nyumbani, kazini au mahali pengine ambapo ilibidi upate matibabu?

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 20

Kama NDIO, endelea na Swali la 1.1
Kama HAPANA, nenda kipengele kinachofuata (Historia ya Ajira)

1.1. Ni mwaka gani lilitokea tukio la mwisho (la hivi karibuni)?

Mwaka __ __ __ __ ☐☐☐☐ 21-24

1.2. Ni wapi lilitokea tukio la mwisho (la hivi karibuni)?

Tafadhali weka alama (X) kwenye jibu moja tu

____Nyumbani (1) ____Kazini (2) ____Mahali pengine (3) ☐ 25

1.3. Ni kemikali gani ilikufikia kwenye mwili wako?

Taja jina/majina ya kemikali

____ ☐☐ 26-27

1.4. Katika masaa 24 ya kwanza tangu tukio la mwisho kutokea, ulipata matatizo yoyote ya kifua kama shida kupumua, sauti kama za filimbi, kikohozi, au kubanwa kifua?

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 28

Kama NDIO, endelea na Swali la 1.5
Kama HAPANA, nenda kipengele kinachofuata (Historia ya Ajira)

1.5. Haya matatizo ya kifua uliyoyapata yalikaa mpaka muda gani? (kipindi ulivyopata matatizo ya kifua ndani ya masaa 24 ya kwanza tangu tukio la mwisho kutokea) ☐ 29

Sijui	< Wiki 1	Wiki 1 - Mwezi 1	> Mwezi 1 lakini < Miezi 3	Miezi 3 au zaidi
1	2	3	4	5

H. HISTORIA YA AJIRA

Historia ya kufanya kazi za kutoa huduma ya afya

1. Tafadhali nitajie umri uliyoanza kufanya kazi katika sekta ya afya AU umri ulioanza kusoma masomo ya huduma za afya

Andika cha kwanza kutokea

Andika kadirio la umri: Miaka _______ 30-31

AU

Andika kadirio la mwaka: Mwaka ___________ 32-35

2. Ni miaka mingapi umefanya kazi za kutoa huduma ya afya? Hii ni pamoja na miaka uliyokuwa unasoma masomo ya hududma za afya

Miaka _______ 36-37

Ajira ya sasa

3. Unafanya kazi gani? 38-39

_____ 3.1. Registered nurse
_____ 3.2. Enrolled nurse
_____ 3.3. Health attendant
_____ 3.4. Cleaner
_____ 3.5. Admin., mtaje:____
_____ 3.6. Porter (mbeba mizigo)
_____ 3.7. Technician/mteknologia, mtaje: ___________________________________

4. Unafanya kazi idara/kitengo/eneo gani? ____________________________ 40-41

5. Umefanya kazi muda gani katika idara/kitengo hiki?

Miaka ______ 42-43
Miezi _______ 44-45

6. Unafanya kazi masaa mangapi kwa wiki katika kazi yako hii?

Masaa kwa wiki _____ _____ 46-47

7. Katika kazi yako hii, unapatwa na vitu vifuatavyo ***mara kwa mara*** : mivuke, gesi, vumbi, au fumes? ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) 48

'Mara kwa mara' ina maana siku nyingi zaidi

Kama NDIO, endelea na Swali la 7.1
Kama HAPANA, nenda Swali la 8

7.1. Ni mivuke, mavumbi na fumes gani ambazo zinakupata mara kwa mara?

____ 49-50
____ 51-52

8. Katika kipindi cha ***miezi 12 iliyopita,*** umeona lolote kati ya haya katika sehemu unazofanyia kazi?

8.1. Maji kuvuja au uharibifu wa maji ndani ya nyumba kama kwenye kuta, sakafu au dari? ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) 53

8.2. Fangasi zinazoonekana ndani ya nyumba (sio kwenye chakula) kama kwenye kuta, sakafu, au dari? ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) 54

8.3. Harufu ya fangasi (sio kwenye chakula)? ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) 55

9.Katika kipindi cha ***miezi 12 iliyopita,*** umeona matengenezo au ujenzi wowote ule ufuatao katika au karibu na maeneo unayofanyia kazi***?***

9.1. Upakaji rangi kwenye ukuta? ___ Yes (1) ___No (2) ___Don't know (3) 56

9.2. Kubandua na kurudishia kuta, mbao, au partitions? ___ Yes (1) ___No (2) ___Don't know (3) 57

9.3. Kubandua na kurudishia sakafu, mazulia, au samani za kudumu? ___ Yes (1) ___No (2) ___Don't know (3) 58

9.4. Mwingine, utaje: ____
____ 59

Matumizi ya sabuni za maji maji za kunawia mikono / Sanitizers

Fikiria kuhusu kazi yako ya sasa na nini umefanya katika kazi hii kwa kipindi cha ***miezi 12 iliyopita*** *:*

10. Unatumia sabuni za maji maji za kunawia mikono/sanitisers kuosha au kudisinfect mikono yako? ____ Ndio (1) ____Hapana (2) ☐ 60

Kama NDIO, endelea na Swali la 10.1
Kama HAPANA, nenda Swali la 11

10.1. Ni sabuni/sanitiser gani unatumia ***kazini?***

- 10.1.1. JET hand wash liquid soap (pink) ____ Ndio (1) ____Hapana (2) ☐ 61
- 10.1.2. TARMOL all pupose cleaner ____ Ndio (1) ____Hapana (2) ☐ 62
- 10.1.3. REGLYD solution (90%) handrub ____ Ndio (1) ____Hapana (2) ☐ 63
- 10.1.4. ANIOSGEL 800 handrub ____ Ndio (1) ____Hapana (2) ☐ 64
- 10.1.5. Sabuni/sanitiser nyingine ________________________________ ☐ 65
  ____ ☐ 66

10.1.1. Ni mara ngapi kwa siku unatumia hizi sabuni/sanitiser katika siku ya ***kawaida kazini?***

- 10.1.1.1. JET hand wash liquid soap (pink) mara _____ /siku ☐☐ 67-68
- 10.1.1.2. TARMOL all pupose cleaner mara _____ /siku ☐☐ 69-70
- 10.1.1.3. REGLYD solution (90%) handrub mara _____ /siku ☐☐ 71-72
- 10.1.1.4. ANIOSGEL 800 handrub mara _____ /siku ☐☐ 73-74
- 10.1.1.5. Sabuni/sanitiser nyingine ___________________ mara _____ /siku ☐☐ 73-74
  ____________________________________ mara _____ /siku ☐☐ 75-76

10.2. Ni sabuni/sanitiser gani unatumia nyumbani***?***

____ ☐☐ 77-78
____ ☐☐ 79-80

10.2.1. Ni mara ngapi kwa siku unatumia hizi sabuni/sanitiser katika siku ya kawaida ***ukiwa nyumbani?*** Card 6

____ mara _____ /siku ☐☐ 1-2
____ mara _____ /siku ☐☐ 3-4

Kemikali za kusafishia / kusterilize vifaa tiba

Fikiria kuhusu kazi yako ya sasa na nini umefanya katika kazi hii kwa kipindi cha ***miezi 12 iliyopita*** *:*

11. Ukiwa kazini, ***unasafisha, kusterilize au kufanya high-level disinfection*** ya vifaa tiba kama bronchoscopes, laryngoscopes, endoscposes, cystoscopes, ***AU*** vyombo vya chuma kama needle holder, forceps, n.k., ***AU*** vyombo vya plastiki kama ear specula za kufanyia uchunguzi sikio?

____ Ndio (1) ____Hapana (2) ☐5

KAMA MSHIRIKI HAJUI, mjaribu jaribu ili kupata kile anachokijua vizuri

Kama NDIO, endelea na Swali la 11.1

Kama HAPANA, nenda Swali la 11.2

11.1. Ukiwa kazini, ni kemikali gani kati ya zifuatazo unazotumia **kusterilize** au kufanya **high-level disinfection** ya vifaaa tiba?

Jina la kemikali

11.1.1. Ortho-phthalaldehydes kama Cidex OPA® au Shieldex OPA® au Cidex OPA® C

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐6

11.1.2. Glutaraldehydes kama Steranios 2% NG® au Cidex®

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐7

11.1.3. Enzymatic cleaners kama Cidezyme® au Sanizyme®

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐8

11.1.4. Kemikali zenye chlorhexidine kama Bioscrub® au D-germ®

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐9

11.1.5. Quaternary ammonium compounds kama MEDDIS®

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐10

11.1.6. Hydrogen peroxide ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐11

11.1.7. Alcohols, kama ethyl alcohol 96% (ethanol), isopropanol, methylated spirits, alcohol 50%, or 70%

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐12

11.1.8. Bleach au chlorine, kama CLORITE BLEACH®, PRESEPT®, CHLOROCIDE® au ZAP BLEACH® ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 13

11.1.9. TARMOL all pupose cleaner® ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 14

11.1.10. Olympus EndoDet® ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 15

11.1.11. Olympus EndoDis® ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 16

11.1.12. Olympus EndoAct® ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 17

11.1.13. Citrosteril® ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 18

11.1.14. Unatumia kemikali ***nyingine*** kusterilize au kufanya high level-disinfection ya vifaa tiba? ____ Ndio (1) ____Hapana (2)

Kama HAPANA, nenda Swali la 11.2
Kama NDIO, endelea na Swali la 11.1.14.1

11.1.14.1. Ni kemikali gani nyingine unazotumia?

(i) ____ ☐☐ 24-25

(ii) ____ ☐☐ 26-27

11.1.15. Kama NDIO kwa swali lolote hapo juu (swali la 11.1), jaza karatasi nyingine pembeni kwa kila kemikali

Tasks

11.2. Katika ***miezi 12 iliyopita,*** umeandaa vifaa tiba kwa ajili ya sterilization kwa kuvifungua/tenganisha vifaa tiba, kuvisafisha ili kuondoa ***uchafu mkubwa mkubwa*** au kuflush uchafu kutoka kwenye vifaa tiba

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 28

Kama HAPANA, nenda Swali la 11.3
Kama NDIO, endelea na Swali la 11.2.1

11.2.1. Wakati ukisafisha vifaa tiba hivi, tafadhali niambie ni siku ngapi kwa wiki, mara ngapi kwa siku na ni muda gani unatumia kufanya shughuli hii

11.2.1.1.	Ni ***siku ngapi kwa wiki*** unafanya shughuli hii? __________					29
11.2.1.2.	Ni ***mara ngapi kwa siku*** unafanya shughuli hii? __________					30-31
11.2.1.3.	Ni ***muda*** gani unatumia kufanya shughuli hii? Masaa __________					32-33
11.2.1.4.	Unatumia gloves?		Ndio (1)	Hapana(2)		34
11.2.1.4.1.	Aina gani?	Latex (1)	Nitrile (2)	Vinyl (3)	Yellow/black domestic (4)	35
11.2.1.5.	Unatumia respirator?		Ndio (1)	Hapana(2)		36
11.2.1.5.1.	Aina gani ya respirator?					37
	Surgical mask				1	
	Particulate respirator such as an N95				2	
	Air purifying half mask				3	
	Air purifying full face piece				4	
	Powered air purifying				5	
11.2.1.6.	Kuna aina gani ya uingizaji hewa katika sehemu yako ya kazi wakati ukiwa unafanya shughuli hii?					
11.2.1.6.1.	Local exhaust ventilation yenye hood na duct ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					38
11.2.1.6.2.	Feni za kutoa hewa kwenye dari ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					39
11.2.1.6.3.	Feni zinazosukuma hewa chafu kuitoa pale alipo mfanyakazi ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					40
11.2.1.6.4.	Uingizaji hewa wa kawaida (madirisha/milango iliyo wazi) ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					41
11.2.1.6.5.	Kiyoyozi ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					42

11.3. Katika kipindi cha ***miezi 12 iliyopita,*** umeandaa kemikali za kuoshea au za kufanyia high-level disinfection kwa ***kuzichanganya*** na maji au kuchanganya kemikali moja na nyingine? ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 42

Kama HAPANA, nenda Swali la 11.4
Kama NDIO, endelea na Swali la 11.3.1

11.3.1. Wakati ukiwa unaandaa kemikali hizi, tafadhali niambie ni siku ngapi kwa wiki, mara ngapi kwa siku, na ni muda gani unatumia kufanya shughuli hii

11.3.1.1.	Ni ***siku ngapi kwa wiki*** unafanya shughuli hii? __________					43
11.3.1.2.	Ni ***mara ngapi kwa siku*** unafanya shughuli hii? __________					44-45
11.3.1.3.	Ni ***muda*** gani unatumia kufanya shughuli hii? Masaa __________					46-47
11.3.1.4.	Unatumia gloves?		Ndio (1)	Hapana(2)		48
11.3.1.4.1.	Aina gani?	Latex (1) / Nitrile (2)	Vinyl (3)	Yellow/black domestic (4)		49
11.3.1.5.	Unatumia respirator?		Ndio (1)	Hapana(2)		50
11.3.1.5.1.	Aina gani ya respirator?					51
	Surgical mask				1	
	Particulate respirator such as an N95				2	
	Air purifying half mask				3	
	Air purifying full face piece				4	
	Powered air purifying				5	
11.3.1.6.	Kuna aina gani ya uingizaji hewa katika sehemu yako ya kazi wakati ukiwa unafanya shughuli hii?					
11.3.1.6.1.	Local exhaust ventilation yenye hood na duct	___ Ndio (1)	___ Hapana (2)	___ Sijui (3)		52
11.3.1.6.2.	Feni za kutoa hewa kwenye dari	___ Ndio (1)	___ Hapana (2)	___ Sijui (3)		53
11.3.1.6.3.	Feni zinazosukuma hewa chafu kuitoa pale alipo mfanyakazi	___ Ndio (1)	___ Hapana (2)	___ Sijui (3)		54
11.3.1.6.4.	Uingizaji hewa wa kawaida (madirisha/milango iliyo wazi)	___ Ndio (1)	___ Hapana (2)	___ Sijui (3)		55
11.3.1.6.5.	Kiyoyozi	___ Ndio (1)	___ Hapana (2)	___ Sijui (3)		56

11.4. Katika kipindi cha ***miezi 12 iliyopita,*** umefanya kazi ya ***kubadilisha*** kemikali za kuoshea au za kufanyia high-level disinfection kwa kuondoa zilizotumika na kuweka nyingine? ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) 56

Kama HAPANA, nenda Swali la 11.5
Kama NDIO, endelea na Swali la 11.4.1

11.4.1. Wakati ukiwa unabadilisha kemikali hizi, tafadhali niambie ni siku ngapi kwa wiki, mara ngapi kwa siku na ni muda gani unatumia kufanya shughuli hii

11.4.1.1.	Ni ***siku ngapi kwa wiki*** unafanya shughuli hii? __________					57
11.4.1.2.	Ni ***mara ngapi kwa siku*** unafanya shughuli hii? __________					58-59
11.4.1.3.	Ni ***muda*** gani unatumia kufanya shughuli hii? Masaa __________					60-61
11.4.1.4.	Unatumia gloves?			Ndio (1)	Hapana(2)	62
11.4.1.4.1.	Aina gani?	Latex (1)	Nitrile (2)	Vinyl (3)	Yellow/black domestic (4)	63
11.4.1.5.	Unatumia respirator?			Ndio (1)	Hapana(2)	64
11.4.1.5.1.	Aina gani ya respirator?					65
	Surgical mask				1	
	Particulate respirator such as an N95				2	
	Air purifying half mask				3	
	Air purifying full face piece				4	
	Powered air purifying				5	
11.4.1.6.	Kuna aina gani ya uingizaji hewa katika sehemu yako ya kazi wakati ukiwa unafanya shughuli hii?					
11.4.1.6.1.	Local exhaust ventilation yenye hood na duct ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					66
11.4.1.6.2.	Feni za kutoa hewa kwenye dari ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					67
11.4.1.6.3.	Feni zinazosukuma hewa chafu kuitoa pale alipo mfanyakazi ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					68
11.4.1.6.4.	Uingizaji hewa wa kawaida (madirisha/milango iliyo wazi) ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					69
11.4.1.6.5.	Kiyoyozi ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					70

11.5. Katika kipindi cha ***miezi 12 iliyopita,*** umetumia vyombo vya ***kutumbukizia*** vifaa (mabeseni au mabakuli makubwa) ili ***kusterilize*** au kufanya ***high-level disinfection*** ya vifaa tiba kwa kutumia mikono?

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) 70

Kama HAPANA, nenda Swali la 11.6
Kama NDIO, endelea na Swali la 11.5.1

11.5.1. Wakati ukitumia vyombo hivi ***kusterilize*** au kufanya ***high-level disinfection*** ya vifaa tiba kwa kutumia mikono, tafadhali niambie ni siku ngapi kwa wiki, mara ngapi kwa siku, na ni muda gani unatumia kufanya shughuli hii

11.5.1.1.	Ni ***siku ngapi kwa wiki*** unafanya shughuli hii? __________					71
11.5.1.2.	Ni ***mara ngapi kwa siku*** unafanya shughuli hii? __________					72-73
11.5.1.3.	Ni ***muda*** gani unatumia kufanya shughuli hii? Masaa __________					74-75
11.5.1.4.	Unatumia gloves?			Ndio (1)	Hapana(2)	76
11.5.1.4.1.	Aina gani?	Latex (1)	Nitrile (2)	Vinyl (3)	Yellow/black domestic (4)	77
11.5.1.5.	Unatumia respirator?			Ndio (1)	Hapana(2)	78
11.5.1.5.1.	Aina gani ya respirator?					79
	Surgical mask				1	
	Particulate respirator such as an N95				2	
	Air purifying half mask				3	
	Air purifying full face piece				4	
	Powered air purifying				5	
11.5.1.6.	Kuna aina gani ya uingizaji hewa katika sehemu yako ya kazi wakati ukiwa unafanya shughuli hii?					Card 7
11.5.1.6.1.	Local exhaust ventilation yenye hood na duct ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					1
11.5.1.6.2.	Feni za kutoa hewa kwenye dari ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					2
11.5.1.6.3.	Feni zinazosukuma hewa chafu kuitoa pale alipo mfanyakazi ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					3
11.5.1.6.4.	Uingizaji hewa wa kawaida (madirisha/milango iliyo wazi) ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					4
11.5.1.6.5.	Kiyoyozi ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					5

11.6. Katika kipindi cha miezi 12 iliyopita, ***umesterilize*** vifaa tiba kwa kutumia mashine/mitambo ya ***kujiendesha yenyewe*** ?

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐5

Kama HAPANA, nenda Swali la 12
Kama NDIO, endelea na Swali la 11.6.1

11.6.1. Ni kazi gani unafanya ukiwa unasterilize vifaa tiba kwa kutumia mashine/mitambo ya ***kujiendesha yenyewe*** ?

Unafanya kazi hizi?

11.6.1.1. Kuendesha mashine/mtambo wa Olympus
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐6

11.6.1.2. Kuendesha mashine/mitambo mingine
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐7

Itaje: ____ ☐8

11.6.2. Unafanya matengenezo kwenye mashine/mitambo hii, kama kuisafisha au kubadilisha vifaa vyake kama screens na filters?
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐9

Tafadhali niambie ni siku ngapi kwa wiki, mara ngapi kwa siku, na ni muda gani unatumia kufanya shughuli hii na kama kuna kifaa kinachonasa na kuondoa gesi na mivuke inayotoka katika mashine/mitambo hii

11.6.3. Mashine/mtambo wa Olympus ☐10

11.6.3.1.	Ni ***siku ngapi kwa wiki*** unafanya shughuli hii? ___________					☐11
11.6.3.2.	Ni ***mara ngapi kwa siku*** unafanya shughuli hii? ___________					☐☐12-13
11.6.3.3.	Ni ***muda*** gani unatumia kufanya shughuli hii? Masaa ___________					☐☐14-15
11.6.3.4.	Unatumia gloves?		Ndio (1)	Hapana(2)		☐16
11.6.3.4.1.	Aina gani?	Latex (1)	Nitrile (2)	Vinyl (3)	Yellow/black domestic (4)	☐17
11.6.3.5.	Unatumia respirator?		Ndio (1)	Hapana(2)		☐18
11.6.3.5.1.	Aina gani ya respirator?					☐19
	Surgical mask				1	
	Particulate respirator such as an N95				2	
	Air purifying half mask				3	
	Air purifying full face piece				4	
	Powered air purifying				5	
11.6.3.6.	Kuna aina gani ya uingizaji hewa katika sehemu yako ya kazi wakati ukiwa unafanya shughuli hii?					
11.6.3.6.1.	Local exhaust ventilation yenye hood na duct ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					☐20
11.6.3.6.2.	Feni za kutoa hewa kwenye dari ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					☐21
11.6.3.6.3.	Feni zinazosukuma hewa chafu kuitoa pale alipo mfanyakazi ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					☐22
11.6.3.6.4.	Uingizaji hewa wa kawaida (madirisha/milango iliyo wazi) ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					☐23
11.6.3.6.5.	Kiyoyozi ___ Ndio (1) ___ Hapana (2) ___ Sijui (3)					☐24

11.6.4. Mashine/mitambo mingine: ____ 24

11.6.4.1.	Ni ***siku ngapi kwa wiki*** unafanya shughuli hii? __________					25
11.6.4.2.	Ni ***mara ngapi kwa siku*** unafanya shughuli hii? __________					26-27
11.6.4.3.	Ni ***muda*** gani unatumia kufanya shughuli hii? Masaa __________					28-29
11.6.4.4.	Unatumia gloves?			Ndio (1)	Hapana(2)	30
11.6.4.4.1.	Aina gani?	Latex (1)	Nitrile (2)	Vinyl (3)	Yellow/black domestic (4)	31
11.6.4.5.	Unatumia respirator?			Ndio (1)	Hapana(2)	32
11.6.4.5.1.	Aina gani ya respirator?					33
	Surgical mask				1	
	Particulate respirator such as an N95				2	
	Air purifying half mask				3	
	Air purifying full face piece				4	
	Powered air purifying				5	

11.6.4.6. Kuna aina gani ya uingizaji hewa katika sehemu yako ya kazi wakati ukiwa unafanya shughuli hii?

11.6.4.6.1. Local exhaust ventilation yenye hood na duct

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) 34

11.6.4.6.2. Feni za kutoa hewa kwenye dari

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) 35

11.6.4.6.3. Feni zinazosukuma hewa chafu kuitoa pale alipo mfanyakazi

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) 36

11.6.4.6.4. Uingizaji hewa wa kawaida (madirisha/milango iliyo wazi)

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) 37

11.6.4.6.5. Kiyoyozi ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) 38

Kemikali za kusafishia / kudisinfect Fixed Surfaces au vifaa

Fikiria kuhusu kazi yako ya sasa na nini umefanya katika kazi hii kwa kipindi cha ***miezi 12 iliyopita*** *:*

12. Ukiwa kazini, unasafisha au kudisinfect fixed surfaces au vifaa?

Mifano ya fixed surfaces are: countertops, sakafu, vitanda and mabafu
Mifano ya vifaa: stendi za kutundikia dripu, matoroli, kompyuta mashine za kupimia presha na stethoscopes

____ Ndio (1) ____Hapana (2) ☐ 38

KAMA MSHIRIKI HAJUI, mjaribu jaribu ili kupata kile anachokijua vizuri
Kama NDIO, endelea na Swali la 12.1
Kama HAPANA, nenda Swali la 15

12.1. Ukiwa kazini, ni kemikali gani unatumia kusafisha au kudisinfect fixed surfaces au vifaa?

Jina la kemikali

12.1.1. Alcohols, kama ethyl alcohol 96% (ethanol), isopropanol, methylated spirits, alcohol 50%, or 70% ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 39

12.1.2. Ammonia, kama Handysan® au Ammonia cleaner ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 40

12.1.3. Bleach au chlorine, kama CLORITE BLEACH®, PRESEPT®, CHLOROCIDE® au ZAP BLEACH® ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 41

12.1.4. TARMOL all pupose cleaner® ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 42

12.1.5. Glass cleaner ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 43

12.1.6. LIT® household cleaner & disinfectant ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 44

12.1.7. HARPIC® Power Plus ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 45

12.1.8. PLANITOL® ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 46

12.1.9. LYSOL® (Cresol saponated liquid 50%) ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 47

12.1.10. Air freshener ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 48

12.1.11. Enzymatic cleaners kama Cidezyme® au Sanizyme® ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 49

12.1.12. Floor wax strippers, kama Multistrip®
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 50

12.1.13. Floor sealer/wax, kama buff spray (diluted floor sealer/wax) au Vision gold®
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 51

12.1.14. Carpet shampoo ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 52

12.1.15. Furniture polish ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 53

12.1.16. Stainless steel cleaner
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 54

12.1.17. Unatumia kemikali nyingine kusafishia fixed surfaces au vifaa?
____ Ndio (1) ____Hapana (2) ☐ 55

Kama NDIO, endelea na Swali la 12.1.16.1
Kama HAPANA, nenda Swali la 13

12.1.17.1. Ni kemikali gani nyingine unatumia?
1. ____ ☐☐ 59-60
2. ____ ☐☐ 61-62

12.1.18. Kama NDIO kwa swali lolote hapo juu (swali la 12.1), jaza karatasi nyingine pembeni kwa kila kemikali

Tasks

Sasa nitakuuliza kuhusu kazi unazofanya ukiwa kazini

13. Unatumia kemikali kwa kupulizia zaidi au kwa kufuta zaidi, au unatumia njia zote sawa ukiwa kazini?

Chagua jibu MOJA tu

13.1 ☐ 63

Natumia kwa kupulizia zaidi ya kufuta	1
Natumia kwa kufuta zaidi ya kupulizia	2
Natumia njia zote sawa	3
Sina uhakika natumia njia ipi zaidi	4

14. Ukiwa kazini, ni ***kazi*** gani unafanya ukiwa unaosha au kudisinfect fixed surfaces, au vifaa?

14.1. Kufuta vitanda, samani, counters, kuta, n.k.
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 64

14.2. Kusafisha damu zilizomwagika na maji maji mengine yaliyomwagika
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 65

14.3. Kuchanganya, kujazia, au kumwaga kemikali za kuoshea au za kudisinfect
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 66

14.4. Kuosha mabafu, choo, na masinki
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 67

14.5. Kupulizia kemikali na kufuta vioo na madirisha
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 68

14.6. Kupolish samani za mbao
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 69

14.7. Kupolish sehemu zenye chuma (stainless steel surfaces)
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 70

14.8. Kupulizia dawa za kuondoka harufu/disinfectant
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 71

14.9. Kufagia sakafu ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 72

14.10. Kusafisha kwa kutumia vacuum
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 73

14.11. Kukung'uta zulia ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 74

14.12. Kudeki ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 75

14.13. Kusafisha vifaa kama mikasi, stethoscopes, kipima joto, stendi za kutundikia dripu, matoroli na kompyuta
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 76

14.14. Kufanya "terminal cleaning" ya vyumba vya wagonjwa
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 77

14.15. Kutumia vifaa vinavyotoa ukungu na hydrogen peroxide au peracetic acid kufanyia "terminal cleaning" ya vyumba vya wagonjwa
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 78

14.16. Kusafisha au kudisinfect kwa sababu ya methicillin-resistant staphylococcus aureus, vancomycin-resistant enterococci au kwa sababu ya vimelea sugu vingine kwenye vyumba vya wagonjwa
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 79

14.17. Kufanya "end of shift cleaning" kwenye vyumba vya upasuaji, vitengo vya dialysis au sehemu nyingine za kuhudumia wagonjwa
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 80

14.18. Kama NDIO kwa swali lolote hapo juu (swali la 14), jaza karatasi nyingine pembeni kwa kila kemikali

15. Katika kipindi cha ***miezi 12 iliyopita,*** umesafisha na kung'arisha sakafu kwa kutumia ***strippers*** na ***buffers?***

___ Ndio (1) ___ Hapana (2) ___ Sijui (3)

Card 8

☐1

Kama NDIO, endelea na Swali la 15.1
Kama HAPANA, nenda Swali la 16

15.1. Ni kazi gani unafanya wakati ukisafisha na kung'arisha sakafu kwa kutumia ***strippers*** na ***buffers?***

15.1.1. Kustrip sakafu

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐2

15.1.2. Kukangua sakafu

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐3

15.1.3. Kubuff sakafu

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐4

15.1.4. Kung'arisha (kuwax) sakafu

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐5

15.1.5. Kama NDIO kwa swali lolote hapo juu (swali la 15.1), jaza karatasi nyingine pembeni kwa kila kemikali

Kemikali zinazotumika kuandaa specimens

16. Huwa unaandaa ***specimens*** kwa ajili ya histology au cytology?

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐6

Kama NDIO, endelea na Swali la 16.1
Kama HAPANA, nenda Swali la 17

16.1. Ni kemikali gani unazotumia kuaandaa specimens kwa ajili ya histology/cytology?

16.1.1. Formalin 10% in normal saline

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐7

16.1.2 Fencott cytological fixative spray

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐8

16.1.3. Stains na dyes kama hematoxylin and eosin stains?

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐9

16.1.4. Solvents kama xylene and toluene za kufix specimens na kusuuza stains

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐10

16.1.5. Kama NDIO kwa swali lolote hapo juu (swali la 16.1), jaza karatasi nyingine pembeni kwa kila kemikali

Kemikali za kutumia kwa wagonjwa

*Fikiria kuhusu kazi yako ya sasa na nini umefanya katika kazi hii kwa kipindi cha **miezi 12 iliyopita** :*

17. Unatumia kemikali kwa wagonjwa?

Mifano:

***Antiseptics** : alcohols kama methylated spirit, povidone iodine, Planitol, chlorhexidine, iodine, silver compounds*

***Adhesives** : glues, acrylates, bone cements*

***Kemikali za kutolea adhesives** : alcohols, acetone, ether*

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 11

KAMA MSHIRIKI HAJUI, mjaribu jaribu ili kupata kile anachokijua vizuri

Kama NDIO, endelea na Swali la 17.1
Kama HAPANA, nenda Swali la 18

17.1. Ni kazi gani unafanya wakati ukiwa unatumia hizi kemikali kwa wagonjwa?

Tasks:

17.1.1. Kudisinfect ngozi za wagonjwa kabla ya ***procedure*** kwa kutumia wipes, gauze, au swabs zenye antiseptics kama povidone iodine au methylated spirit au Planitol ___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 12

17.1.2. Kusafisha na kudisinfect ***vidonda*** kwa kutumia antiseptics kama kemikali zenye silver, Biotane in alcohol, povidone iodine, au Planitol
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 13

17.1.3. ***Kufunga vidonda*** kwa kutumia polyurethane based hydrogel, hydrocolloid, au hydrocellular foam
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 14

17.1.4. Kutumia ***adhesives*** kama gundi, acrylates, simenti za mifupa, benzoin tincture mfano Opsite, 3M Steri-Strip® wakati wa upasuaji, kuziba sehemu ya ngozi, kuunga mfupa, ostomy bags, na matumizi mengine
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 15

17.1.5. Kutumia ***kemikali za kutolea adhesives*** kama ether, alcohols au acetone kwenye wipes, gauze, au swabs
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 16

17.1.6. Kuweka au kutoa synthetic fiberglass orthopaedic casts
___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 17

17.1.7. Kama NDIO kwa swali lolote hapo juu (swali la 17.1), jaza karatasi nyingine pembeni kwa kila kemikali

__Dawa za kuvuta (aerosolized medicines) zinazotumiwa na wagonjwa__

Fikiria kuhusu kazi yako ya sasa na nini umefanya katika kazi hii kwa kipindi cha ***miezi 12 iliyopita*** *:*

18. Huwa unatoa kwa wagonjwa ***dawa za kuvuta*** kama bronchodilators au dawa za usingizi?

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 18

KAMA MSHIRIKI HAJUI, mjaribu jaribu ili kupata kile anachokijua vizuri

Kama NDIO, endelea na Swali la 18.1
Kama HAPANA, nenda kipengele kinachofuata (Ajira za kipindi cha nyuma)

18.1. Ni kazi gani huwa unafanya wakati ukiwa unatoa dawa za ***kuvuta?***

Tasks

18.1.1. Kutoa dawa za kuvuta kwa kutumia ***small volume nebulizer (SVN)***

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 19

18.1.2. Kutumia ***continuous aerosol delivery system*** kwa ajili ya bronchodilators na dawa nyingine

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 20

18.1.3. Kutoa dawa za kuvuta kwa kutumia ***metered-dose inhaler (MDI)***

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 21

18.1.4. Kutoa dawa za kuvuta kwa kutumia ***dry powder inhaler (DPI)***

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 22

18.1.5. Kama NDIO kwa swali lolote hapo juu (swali la 18.1), jaza karatasi nyingine pembeni kwa kila kemikali

I. AJIRA ZA KIPINDI CHA NYUMA

Sasa ntakuuliza maswali kuhusu kazi ulizokuwa unafanya kipindi cha ***nyuma hapa hospitalini:***

1. Nitajie kazi zote za ***nyuma*** ulizowahi kuwa nazo **hapa hospitalini:**

Anza na kazi ya kwanza kabisa uliyowahi kuwa nayo

Idara/ Kitengo/ Eneo	**Jina la kazi** (ulifanya kazi gani?)	**Mwaka ulioanza kazi**	**Mwaka wa mwisho kufanya kazi**	**Ni masaa mangapi kwa siku ulifanya?**	**Ulikuwa unapata mivuke, gesi, mavumbi, fumes mara kwa mara?**

Sasa nitakuuliza maswali kuhusu ajira zako za ***nyuma katika sekta ya afya, lakini sio katika hospitali hii:***

2. Nitajie sehemu zote ulizowahi kufanya kazi, wakati ukiwa hufanyi hapa hospitalini, au ***kabla hujaanza kazi hapa hospitalini:***

Anza na kazi ya kwanza kabisa uliyowahi kuwa nayo

Jina la sehemu ya kazi	**Aina**	**Jina la kazi** (ulifanya kazi gani?)	**Mwaka ulioanza kazi**	**Mwaka wa mwisho kufanya kazi**	**Ni masaa mangapi kwa siku ulifanya?**	**Ulikuwa unapata mivuke, gesi, mavumbi, fumes mara kwa mara?**

Sasa nitakuuliza maswali kuhusu ajira zako za nyuma ***(nje ya sekta ya afya)***

3. Nitajie sehemu zote ulizowahi kufanya kazi ***(nje ya sekta ya afya):***

Anza na kazi ya kwanza kabisa uliyowahi kuwa nayo

Jina la sehemu ya kazi	**Sekta**	**Jina la kazi (ulifanya kazi gani?)**	**Mwaka ulioanza kazi**	**Mwaka wa mwisho kufanya kazi**	**Jumla ya miaka**

Kubadilisha kazi

4. Umeshawahi kuacha au kubadilisha kazi au eneo la kazi kwasababu iliathiri upumuaji wako? Hii ni pamoja na kubadilisha kazi au eneo la kazi lakini bado ukiwa *hospitali ile ile / mahali pale pale pa kazi*

___ Ndio (1) ___ Hapana (2) ___ Sijui (3) ☐ 23

Kama NDIO, endelea na Swali la 4.1
Kama HAPANA, nenda kipengele kinachofuata (Work-related symptoms)

Tafadhali jibu maswali yafuatayo kuhusu ***mara yako ya mwisho kabisa*** *kuacha au kubadilisha kazi au eneo la kazi kwasababu imeathiri upumuaji wako.*

4.1. Ni mwaka gani uliacha au kubadili kazi au eneo la kazi?

Mwaka: __ __ __ __ ☐☐☐☐ 24-27

4.2. Ni aina gani ya kazi au eneo la kazi ulilooondoka au kubadili?

____ ☐☐ 28-29

____

4.3. Ni shughuli gani ulikuwa unafanya katika kazi hiyo au eneo hilo la kazi ulilooondoka au kubadili? ____ ☐☐ 30-31

____

____

4.4. Ni kitu gani kiliathiri upumuaji wako hapo kwenye hiyo kazi au eneo hilo la kazi ulilooondoka au kubadili? ____ ☐☐ 32-33

____ ☐☐ 34-35

4.5. Kuhusu <u>*kazi au eneo la kazi uliloenda:*</u> Ni kazi gani au eneo gani la kazi uliloenda? ____ ☐☐ 36-37

____

4.6. Ulifanya shughuli gani katika kazi hii au eneo hili jipya la kazi?

____ ☐☐ 38-39

____

4.7. Naomba nitajie jina la kampuni hii mpya uliyoenda kufanya kazi

____ ☐☐ 40-41

4.8. Matatizo (yako ya upumuaji) yalipungua ulivyobadili kazi au eneo la kazi?

____ Ndio (1) ____Hapana (2) ☐ 42

J. MATATIZO YA KIAFYA YANAYOHUSIANA NA KAZI

Matatizo ya kifua yanayohusiana na kazi

Fikiria kuhusu maisha yako yote ukiwa unafanya kazi na matatizo yako ya pumu ukiwa kazini:

1. Je, kuwa kwako kazini kunasababisha/kulisababisha kifua chako kubana, kusikia sauti kama za filimbi, au kupumua kwa shida?

____ Ndio (1) ____Hapana (2) ☐ 43

Kama NDIO, endelea na Swali la 1.1
Kama HAPANA, nenda Swali la 2

1.1. Ni tangu lini ulianza kupata matatizo haya ya kifua ukiwa kazini?

Mwezi ______ Mwaka __________ ☐☐☐☐ 44-47

1.2. Unafikiri ni nini kinasababisha/kilisababisha haya matatizo?

Workplace triggers

Sijui	__Y(1) __N(2)	☐ 48
Ortho-phthalaldehydes, kama Cidex OPA®, Shieldex OPA®, Cidex OPA® C	__Y(1) __N(2)	☐ 49
Glutaraldehydes, kama Steranios® au Cidex®	__Y(1) __N(2)	☐ 50
Enzymatic cleaners, kama Cidezyme® au Sanizyme®	__Y(1) __N(2)	☐ 51
Kemikali zenye chlorhexidine kama Savlon®, Bioscrub®, D-germ®,	__Y(1) __N(2)	☐ 52
Quaternary ammonium compounds kama MEDDIS®	__Y(1) __N(2)	☐ 53
Bleach au chlorine, kama Clorite®, ZAP®, Presept®, Chlorocide®	__Y(1) __N(2)	☐ 54
Ammonia, kama Handysan, Ammonia cleaner (cleaner all purpose)	__Y(1) __N(2)	☐ 55
TARMOL all purpose cleaner®	__Y(1) __N(2)	☐ 56
Kemikali nyingine za kusterilise au kufanya high-level disinfection ya vifaa tiba	__Y(1) __N(2)	☐ 57
Kemikali nyingine za kuoshea fixed surfaces	__Y(1) __N(2)	☐ 57
Strippers au waxes za sakafu	__Y(1) __N(2)	☐ 58
Sabuni nyingine za maji maji za kunawia mikono/sanitisers	__Y(1) __N(2)	☐ 59
Adhesives, gundi, au kemikali za kuondoa adhesives	__Y(1) __N(2)	☐ 60
Dawa za kuvuta (aerosolised medicines)	__Y(1) __N(2)	☐ 61
Gesi au mivuke	__Y(1) __N(2)	☐ 62
Vitu venye latex	__Y(1) __N(2)	☐ 63
Hali ya ubaridi sana au joto sana	__Y(1) __N(2)	☐ 64
Vumbi, tafadhali taja aina ya vumbi (vumbi la karatasi, n.k.): _________	__Y(1) __N(2)	☐ 65
Nyingine, tafadhali zitaje:	__Y(1) __N(2)	☐ 66
a) ____________________________		☐ 67
b) ____________________________		☐ 68
c) ____________________________		☐ 69
d) ____________________________		☐ 70

Fikiria kuhusu miezi 12 iliyopita:

1.3. Katika kipindi cha ***miezi 12 iliyopita,*** umepata matatizo haya ya kifua wakati ukiwa kazini muda wowote ule? ____ Ndio (1) ____Hapana (2) ☐71

Kama NDIO, endelea na Swali la 1.3.1
Kama HAPANA, nenda Swali la 1.4

1.3.1. Wakati ukiwa ***haupo kazini*** (kwa mfano wikiendi au ukiwa likizo) katika kipindi hiki cha ***miezi 12 iliyopita,*** matatizo yako ya kifua huwa yanapungua, au yanakuwa mabaya zaidi au yanakuwa vile vile?

Uliza maswali yote matatu (3) kwa wakati mmoja
Weka alama ya (X) mbele ya jibu moja sahihi

☐72

a) Yanakuwa vile vile ______
b) Yanapungua ______
c) Yanakuwa mabaya zaidi ______

1.3.2. Baada ya ***kurudi kazini*** katika kipindi hiki cha ***miezi 12 iliyopita,*** matatizo yako ya kifua huwa yanapungua, au yanakuwa mabaya zaidi au yanakuwa vile vile?

Uliza maswali yote matatu (3) kwa wakati mmoja
Weka alama ya (X) mbele ya jibu moja sahihi

☐73

a) Yanakuwa vile vile ______
b) Yanapungua ______
c) Yanakuwa mabaya zaidi ______

1.4. Ulishawahi kuambiwa na daktari kwamba pumu yako inahusiana na kazi yoyote uliyowahi kufanya? ____ Ndio (1) ____Hapana (2) ☐74

Kama NDIO, endelea na Swali la 1.4.1
Kama HAPANA, nenda Swali la 2

1.4.1. Ulikuwa una umri gani au ni mwaka upi daktari aligundua hilo kwa mara ya kwanza kabisa?

Andika kadirio la umri: Miaka _______ ☐☐75-76
AU
Andika kadirio la mwaka: Mwaka ___________ ☐☐☐☐77-80

1.4.2. Ulikuwa unafanya kazi wapi wakati ulipopata haya matatizo kwa mara ya kwanza?

Card 9
☐1

____ 1. Ajira kwenye sekta ya afya
____ 2. Ajira nje ya sekta ya afya
____ 3. Mwanafunzi, tafadhali fafanua: ____________________________________ ☐2

Matatizo ya pua na macho yanayohusiana na kazi

Fikiria kuhusu maisha yako yote ukiwa unafanya kazi na matatizo yako ya pua na macho ukiwa kazini:

2. Je, kuwa kwako kazini kunasababisha/kulisababisha wewe kupiga chafya/ pua kuwasha/ kutokwa makamasi au macho kuwa mekundu/kuwasha/kutoa machozi?
____ Ndio (1) ____Hapana (2) ☐ 3

Kama NDIO kwa mojawapo ya hayo, endelea na Swali la 2.1
Kama HAPANA, nenda Swali la 3

2.1. Ni tangu lini ulianza kupata matatizo haya ukiwa kazini?
Mwezi ______ Mwaka __________ ☐☐☐☐ 4-7

2.2. Unafikiri ni nini kinasababisha/kilisababisha haya matatizo?

Workplace triggers

Sijui	__Y(1) __N(2)	☐	8
Ortho-phthalaldehydes, kama Cidex OPA®, Shieldex OPA®, Cidex OPA® C	__Y(1) __N(2)	☐	9
Glutaraldehydes, kama Steranios® au Cidex®	__Y(1) __N(2)	☐	10
Enzymatic cleaners, kama Cidezyme® au Sanizyme®	__Y(1) __N(2)	☐	11
Kemikali zenye chlorhexidine kama Savlon®, Bioscrub®, D-germ®,	__Y(1) __N(2)	☐	12
Quaternary ammonium compounds kama MEDDIS®	__Y(1) __N(2)		
Bleach au chlorine, kama Clorite®, ZAP®, Presept®, Chlorocide®	__Y(1) __N(2)	☐	13
Ammonia, kama Handysan, Ammonia cleaner (cleaner all purpose)	__Y(1) __N(2)	☐	14
TARMOL all purpose cleaner®	__Y(1) __N(2)	☐	15
Kemikali nyingine za kusterilise au kufanya high-level disinfection ya vifaa tiba	__Y(1) __N(2)	☐	16
Kemikali nyingine za kuoshea fixed surfaces	__Y(1) __N(2)	☐	17
Strippers au waxes za sakafu	__Y(1) __N(2)	☐	18
Sabuni nyingine za maji maji za kunawia mikono/sanitisers	__Y(1) __N(2)	☐	19
Adhesives, gundi, au kemikali za kuondoa adhesives	__Y(1) __N(2)	☐	20
Dawa za kuvuta (aerosolised medicines)	__Y(1) __N(2)	☐	21
Gesi au mivuke	__Y(1) __N(2)	☐	22
Vitu venye latex	__Y(1) __N(2)	☐	23
Hali ya ubaridi sana au joto sana	__Y(1) __N(2)	☐	24
Vumbi, tafadhali taja aina ya vumbi (vumbi la karatasi, n.k.): _________	__Y(1) __N(2)	☐	25
Nyingine, tafadhali zitaje:	__Y(1) __N(2)	☐	26
a) ____________________________		☐	27
b) ____________________________		☐	28
c) ____________________________		☐	29
d) ____________________________		☐	30

Fikiria kuhusu miezi 12 iliyopita:

2.3. Katika kipindi cha ***miezi 12 iliyopita,*** umepata matatizo haya wakati ukiwa kazini muda wowote ule? ____ Ndio (1) ____Hapana (2) ☐31

Kama NDIO, endelea na Swali la 2.3.1
Kama HAPANA, nenda Swali la 2.4

2.3.1. Wakati ukiwa ***haupo kazini*** (kwa mfano wikiendi au ukiwa likizo) katika kipindi hiki cha ***miezi 12 iliyopita,*** haya matatizo yako huwa yanapungua, au yanakuwa mabaya zaidi au yanakuwa vile vile?

Uliza maswali yote matatu (3) kwa wakati mmoja
Weka alama ya (X) mbele ya jibu moja sahihi

☐32

a) Yanakuwa vile vile ______
b) Yanapungua ______
c) Yanakuwa mabaya zaidi ______

2.3.2. Baada ya ***kurudi kazini*** katika kipindi hiki cha ***miezi 12 iliyopita,*** matatizo yako huwa yanapungua, au yanakuwa mabaya zaidi au yanakuwa vile vile?

Uliza maswali yote matatu (3) kwa wakati mmoja
Weka alama ya (X) mbele ya jibu moja sahihi

☐33

a) Yanakuwa vile vile ______
b) Yanapungua ______
c) Yanakuwa mabaya zaidi ______

2.4. Ulishawahi kuambiwa na daktari kwamba matatizo yako ya pua na macho yanahusiana na kazi yoyote uliyowahi kuifanya?
____ Ndio (1) ____Hapana (2) ☐34

Kama NDIO, endelea na Swali la 2.4.1
Kama HAPANA, nenda Swali la 3

2.4.1. Ulikuwa una umri gani au ni mwaka upi daktari aligundua hilo kwa mara ya kwanza kabisa?

Andika kadirio la umri: Miaka _______ ☐☐35-36
AU
Andika kadirio la mwaka: Mwaka ___________ ☐☐☐☐37-40

2.4.2. Ulikuwa unafanya kazi wapi wakati ulipopata haya matatizo kwa mara ya kwanza? ☐41
____ 1. Ajira kwenye sekta ya afya
____ 2. Ajira nje ya sekta ya afya
____ 3. Mwanafunzi, tafadhali fafanua: ____________________________________ ☐42

Matatizo ya ngozi yanayohusiana na kazi

Fikiria kuhusu maisha yako yote ukiwa unafanya kazi na matatizo yako ya ngozi ukiwa kazini:

3. Je, kuwa kwako kazini kunasababisha/kulisababisha wewe kupata matatizo ya ngozi? ____ Ndio (1) ____Hapana (2) ☐ 43

Kama NDIO, endelea na Swali la 3.1
Kama HAPANA, hapa ndio mwisho wa mahojiano

3.1. Ni tangu lini ulianza kupata matatizo haya ya ngozi ukiwa kazini?
Mwezi ______ Mwaka __________ ☐☐☐☐ 44-47

3.2. Unafikiri ni nini kinasababisha/kilisababisha haya matatizo?

Workplace triggers		
Sijui	__Y(1) __N(2)	☐ 48
Ortho-phthalaldehydes, kama Cidex OPA®, Shieldex OPA®, Cidex OPA® C	__Y(1) __N(2)	☐ 49
Glutaraldehydes, kama Steranios® au Cidex®	__Y(1) __N(2)	☐ 50
Enzymatic cleaners, kama Cidezyme® au Sanizyme®	__Y(1) __N(2)	☐ 51
Kemikali zenye chlorhexidine kama Savlon®, Bioscrub®, D-germ®,	__Y(1) __N(2)	☐ 52
Quaternary ammonium compounds kama MEDDIS®	__Y(1) __N(2)	
Bleach au chlorine, kama Clorite®, ZAP®, Presept®, Chlorocide®	__Y(1) __N(2)	☐ 53
Ammonia, kama Handysan, Ammonia cleaner (cleaner all purpose)	__Y(1) __N(2)	☐ 54
TARMOL all purpose cleaner®	__Y(1) __N(2)	☐ 55
Kemikali nyingine za kusterilise au kufanya high-level disinfection ya vifaa tiba	__Y(1) __N(2)	☐ 56
Kemikali nyingine za kuoshea fixed surfaces	__Y(1) __N(2)	☐ 57
Strippers au waxes za sakafu	__Y(1) __N(2)	☐ 58
Sabuni nyingine za maji maji za kunawia mikono/sanitisers	__Y(1) __N(2)	☐ 59
Adhesives, gundi, au kemikali za kuondoa adhesives	__Y(1) __N(2)	☐ 60
Dawa za kuvuta (aerosolised medicines)	__Y(1) __N(2)	☐ 61
Gesi au mivuke	__Y(1) __N(2)	☐ 62
Vitu venye latex	__Y(1) __N(2)	☐ 63
Hali ya ubaridi sana au joto sana	__Y(1) __N(2)	☐ 64
Vumbi, tafadhali taja aina ya vumbi (vumbi la karatasi, n.k.): _________	__Y(1) __N(2)	☐ 65
Nyingine, tafadhali zitaje:	__Y(1) __N(2)	☐ 66
a) ______________________________		☐ 67
b) ______________________________		☐ 68
c) ______________________________		☐ 69
d) ______________________________		☐ 70

Fikiria kuhusu miezi 12 iliyopita:

3.3. Katika kipindi cha ***miezi 12 iliyopita,*** umepata matatizo haya wakati ukiwa kazini muda wowote ule? ____ Ndio (1) ____Hapana (2) ☐71

Kama NDIO, endelea na Swali la 3.3.1
Kama HAPANA, nenda Swali la 3.4

3.3.1. Wakati ukiwa ***haupo kazini*** (kwa mfano wikiendi au ukiwa likizo) katika kipindi hiki cha ***miezi 12 iliyopita,*** haya matatizo yako huwa yanapungua, au yanakuwa mabaya zaidi au yanakuwa vile vile?

Uliza maswali yote matatu (3) kwa wakati mmoja
Weka alama ya (X) mbele ya jibu moja sahihi

☐72

a) Yanakuwa vile vile ______
b) Yanapungua ______
c) Yanakuwa mabaya zaidi ______

3.3.2. Baada ya ***kurudi kazini*** katika kipindi hiki cha ***miezi 12 iliyopita,*** matatizo yako huwa yanapungua, au yanakuwa mabaya zaidi au yanakuwa vile vile?

Uliza maswali yote matatu (3) kwa wakati mmoja
Weka alama ya (X) mbele ya jibu moja sahihi

☐73

a) Yanakuwa vile vile ______
b) Yanapungua ______
c) Yanakuwa mabaya zaidi ______

3.4. Ulishawahi kuambiwa na daktari kwamba matatizo yako ya ngozi yanahusiana na kazi yoyote uliyowahi kuifanya? ☐74

____ Ndio (1) ____Hapana (2)

Kama NDIO, endelea na Swali la 3.4.1
Kama HAPANA, hapa ndio mwisho wa mahojiano

3.4.1. Ulikuwa una umri gani au ni mwaka upi daktari aligundua hilo kwa mara ya kwanza kabisa?

Andika kadirio la umri: Miaka _______ ☐☐75-76
AU
Andika kadirio la mwaka: Mwaka ___________ ☐☐☐☐77-80

Card 10

3.4.2. Ulikuwa unafanya kazi wapi wakati ulipopata haya matatizo kwa mara ya kwanza? ☐1

____ 1. Ajira kwenye sekta ya afya
____ 2. Ajira nje ya sekta ya afya ☐2
____ 3. Mwanafunzi, tafadhali fafanua: ____________________________________

ASANTE SANA KWA USHIRIKI WAKO

RISK FACTORS FOR WORK-RELATED ASTHMA IN HEALTH CARE WORKERS WITH EXPOSURE TO DIVERSE CLEANING AGENTS – 2014

LUNG FUNCTION TESTS--Pretest Questionnaire

a. Survey Number ______________ ☐☐☐ 1-3

b. Staff Number ______________________ ☐☐☐☐☐☐☐☐ 4-11

c. Interviewer's initials: ____________________ ☐☐ 12-13

d. Date of interview:
Day____Month________Year__________ ☐☐☐☐☐☐☐☐ 14-21

1. Have you had any recent operation (in the last 12 months)?
Yes (1) No (2) ☐ 22

1.1 If ***Yes***, what type and how many months ago? ☐ 23
____
____

1.2 How many months ago? ________ ☐☐ 24-25

2. Have you had a heart attack or stroke in the last 3 months?
Yes (1) No (2) ☐ 26

3. Do you have epilepsy?
Yes (1) No (2) ☐ 27

> If **YES** to ***any*** of the above no. 1-3, indicate to the person that the lung function tests will not be done.
> Otherwise proceed with the questions below.

4. Are you being treated for Tuberculosis (TB)?
Yes (1) No (2) ☐ 28

4.1 If **Yes**, for how long? ________months ________weeks ☐☐☐☐ 29-32

5. Have you had the flu or sinusitis or a lung infection in the past 3 weeks? Yes (1) No (2) ☐ 33

> If **YES**, to question no. 4 or 5, indicate to person that the tests will not be done today. Schedule another appointment in **three weeks** from the end of their **illness** or **three months** time from the start of their **TB medication**.

6.For women:

6.1 Are you Pregnant?
Yes (1) No (2) Don't know (3) ☐ 34

6.2 If **Don't know:** Would you like to perform a urinary pregnancy test to make sure?
Yes (1) No (2) ☐ 35

6.3 Are you Breastfeeding? Yes (1) No (2) 36

If **Pregnant**, indicate to the person that the spirometry and methacholine tests will **NOT** be done today, but proceed with the exhaled nitric oxide test.

If **Breastfeeding**, proceed with spirometry test with post-bronchodilator. Otherwise proceed with the questions below.

ALCOHOL CONSUMPTION

7. Do you drink alcohol? Yes (1) No (2) 37

7.1 If **Yes**, when have you last consumed alcohol? 38

1-2 hours ago (1)
1 day ago (2)
1 week ago (3)

7.2 How much alcohol did you consume? Units: _________ 39-40
(1 unit = 1 beer, 1 glass of wine, 1 tot of spirits)

GREEN VEGETABLE CONSUMPTION

8. How often do you eat the following vegetable products?

Type of product	Daily	1 to 3 times a week	1 to 3 times a month	Never	
8.1. Green salad	1	2	3	4	41
8.2. Spinach & other green leafy vegetables	1	2	3	4	42

9. When did you last consume green salad and/or spinach/ other green leafy vegetables? 43

1-2 hours ago (1)
1 day ago (2)
1 a week ago (3)

PHYSICAL ACTIVITY

10. Do you exercise? Yes (1) No (2) 44

11. When was the last time you exercised? 45

1-2 hours ago (1)
1 day ago (2)
1 week ago (3)

SPIROMETRY/LUNG FUNCTION TEST

12. Have you ever had a spirometry/lung function test?
Yes (1) No (2) 46

12.1 If **yes,** when last did you blow into a lung function machine? 47

1-2 hours ago (1)
1 day ago (2)
1 week ago (3)
> a week ago (4)

RECENT ORAL INTAKE

13. Did you have anything to eat or drink in the last hour? Yes (1) No (2) ☐ 48

14. Have you smoked in the last hour? Yes (1) No (2) ☐ 49

> If **YES** to no. 13 or 14, reschedule nitric oxide test for at least 1 hour later the same day or for another date.

15. Have you had asthma in the past? Yes (1) No (2) ☐ 50

16. Do you have asthma now? Yes (1) No (2) ☐ 51

17. Are you taking any medicine(s) from a doctor or clinic at the moment for your chest OR any heart condition OR for your eyes? Yes (1) No (2) ☐ 52

17.1 If **YES**, what are you taking and when did you last take them?

Names:	Hours since last dose:		
____________	______	☐☐	53-54
____________	______	☐☐	55-56
____________	______	☐☐	57-58
____________	______	☐☐	59-60

> If Beta-Blockers such as Atenolol, Carvedilol etc. are being used—**DO NOT** perform **methacholine challenge test**. Additionally, if anti-cholinesterase medication such as Pyridostigmine for Myasthenia gravis is being used —**DO NOT** perform **methacholine challenge test**.

> If short-acting beta-2-agonist or anti-cholinergic inhalers have been used in the **last 4 hours** or long-acting MDI or theophylline have been used in **last 8 hours**, reschedule and counsel accordingly.

18. Do you currently have any of these symptoms?

18.1 chest tightness Yes (1) No (2) ☐ 61

18.2 shortness of breath Yes (1) No (2) ☐ 62

18.3 wheezing or whistling in your chest Yes (1) No (2) ☐ 63

18.4 dry cough Yes (1) No (2) ☐ 64

19. If **YES** to any of the above:

19.1 Are you feeling very unwell today? Yes (1) No (2) ☐ 65

> If **YES** to no. 19.1: Consult with the doctor on site whether to proceed with spirometry and methacholine challenge test.

END

RISK FACTORS FOR WORK-RELATED ASTHMA IN HEALTH CARE WORKERS WITH EXPOSURE TO DIVERSE CLEANING AGENTS – 2014

LUNG FUNCTION TESTS—DATA COLLECTION SHEET

Card 1

Survey Number	☐☐☐	1-3
Staff number	☐☐☐☐☐☐☐☐	4-11
Date	DAY ☐☐ MONTH ☐☐ YEAR ☐☐	12-17

1. Subject’s blood pressure ☐☐☐ systolic

[DO NOT PROCEED WITH MCT IF BP >180/110] ☐☐☐ diastolic

2. Subject's age — YEARS ☐☐ 18-19

3. Subject's gender — MALE ☐ FEMALE ☐ 20

4.1 Subject's height — CENTIMETRES ☐☐☐ 21-23

4.2 Subject's weight — KILOGRAMS ☐☐☐ 24-26

5. When did you last work? Date ☐☐ ☐☐ ☐☐ 27-32

BASELINE SPIROMETRY

6. **PREDICTED FEV_1** ☐ ☐☐ 33-35

7. **INITIAL FEV_1 and FVC**
(up to 8 attempts)

	FEV_1		FVC		
1	☐	☐☐	☐	☐☐	36-41
2	☐	☐☐	☐	☐☐	42-47
3	☐	☐☐	☐	☐☐	48-53
4	☐	☐☐	☐	☐☐	54-59
5	☐	☐☐	☐	☐☐	60-65

7.1 Number of rejected attempts ☐ 66

8. **Best INITIAL FEV_1 as % of predicted FEV_1** ☐☐☐ 67-69
(divide best results from No. 7 by results from No. 6)

IF BEST INITIAL FEV_1 IS: **a) less than 70% PREDICTED <u>or</u>**
b) less than 1.5 LITRES <u>or</u>
the individual is: **c) Breastfeeding**

GO TO BRONCHODILATOR CHALLENGE—DO <u>NOT</u> DO METHACHOLINE CHALLENGE

<u>BRONCHODILATOR CHALLENGE ONLY</u> *(following 4 puffs of 100 mcg)*

9. **FEV_1 and FVC**

	FEV_1	FVC	Card 2
9.1 Record Best two technically satisfactory Manoeuvres (up to 8 attempts)	☐ ☐☐	☐ ☐☐	1-6
	☐ ☐☐	☐ ☐☐	7-12
9.2 Number of rejected attempts		☐	13

<u>METHACHOLINE CHALLENGE TEST</u>

10. **CONTROL FEV_1** following inhalation of diluent

10.1 Record two technically satisfactory manoeuvres (up to 3 attempts) ☐ ☐☐ 14-16
☐ ☐☐ 17-19

10.2 Number of rejected attempts ☐ 20

11. **BEST CONTROL (post-diluent) FEV_1 as % of INITIAL FEV_1** ☐☐☐ 21-23
(divide best results from No. 10 by best results from No. 7)

IF BEST CONTROL FEV_1 <90% OF <u>BEST</u> INITIAL FEV_1 <u>STOP METHACHOLINE CHALLENGE</u> AND

GO TO REVERSAL OF BRONCHOCONSTRICTION

<u>Choice of methacholine short, medium, long protocol, standard</u>

STOP METHACHOLINE CHALLENGE if FEV_1 falls to <80% of CONTROL FEV_1
(multiply no. 10 by 0.8)

80% of **CONTROL FEV_1** ☐ ☐☐

12. DID THE SUBJECT ANSWER 'YES' TO QUESTIONS 9, 11 & 12 OF THE LFT Pre-Test? NO ☐ YES ☐

12.1 Which protocol will the subject follow? ☐ 24

13. METHACHOLINE BATCH NUMBER ____________ ☐☐ 25-26

DOSE LEVEL	DOSE (mg of 32 mg/ml)	Best FEV_1	2^{nd} Best FEV_1	Rejected attempts	
1	Diluent				27-33
2	0.0256				34-40
3	0.032				41-47
4	0.064				48-54
5	0.128				55-61
6	0.256				62-68
7	0.512				Card 3 1-7
8	1.024				8-14
9	2.048				15-21

14. Why was methacholine challenge stopped?

TICK ONE BOX ONLY

a) best CONTROL FEV_1 < 90% of best INITIAL FEV_1 22
b) end of test reached (2.048mg of 32 mg/ml inhaled) 23
c) >/= 20% fall in FEV_1 occurred 24
d) subject asked to stop: reason; ________________________________ 25
e) other: ____ 26

All participants will have a bronchodilator at the completion of the test with post-bronchodilator LFT results recorded below.

Reversal of bronchoconstriction

ADMINISTER 4 PUFFS OF SALBUTAMOL, WAIT FOR 10 MINUTES, AND THEN PERFORM PFT'S TO RESTORE BASELINE LUNG FUNCTION

15. **FEV_1 and FVC**

	FEV_1	FVC	
15.1 Record Best two technically satisfactory manoeuvres (up to 3 attempts)			27-32
			33-38

15.2 Number of rejected attempts 39

16. **Best POST-BRONCHODILATOR FEV_1 as % of initial FEV_1** 40-42

(divide best results from No.15 by best results from No.7)

17. Has subject's FEV_1 returned to within 10% of baseline spirometry? NO YES 43

IF 'YES' THE SUBJECT MAY LEAVE THE CENTRE
IF 'NO' ADMINISTER ANOTHER 4 PUFFS OF SALBUTAMOL AND WAIT ANOTHER 10 MIN, THEN PERFORM PFT'S TO RESTORE BASELINE LUNG FUNCTION

18. **FEV_1 and FVC**

	FEV_1	FVC	
18.1 Record Best two technically satisfactory manoeuvres (up to 3 attempts)	☐ ☐☐	☐ ☐☐	44-49
	☐ ☐☐	☐ ☐☐	50-55

18.2 Number of rejected attempts ☐ 56

19. **Best 2nd POST-BRONCHODILATOR FEV_1 as % of initial FEV_1** ☐☐☐ 57-59

(divide best results from No. 18 by best results from No. 7)

	NO	YES	
20. Has subject's FEV_1 returned to within 10% of baseline spirometry?	☐	☐	60

All participants to answer questions below. Tick the relevant box.

21. Did the subject experience any of the following symptoms during the challenge test?

	NO	YES	
21.1 Dry or sore throat / hoarse voice	☐	☐	61
21.2 Cough	☐	☐	62
21.3 Chest tightness/wheeze/shortness of breath	☐	☐	63
21.4 Headaches/dizziness	☐	☐	64
21.1 Other	☐	☐	65

Specify ____

22. General comments:

____

____

23. Technologist initials: _______________ ☐ 66

24. Room temperature (C°): _______________ ☐☐ 67-68

	NO	YES	
25 Lung function record attached?	☐	☐	69

Appendix E: Exhaled nitric oxide data collection sheet

RISK FACTORS FOR WORK-RELATED ASTHMA IN HEALTH CARE WORKERS WITH EXPOSURE TO DIVERSE CLEANING AGENTS – 2014

EXHALED NITRIC OXIDE--Data Collection Sheet

Survey Number	____________	☐☐☐	1-3
Date:	____________		
Time	____________		
Ambient NO concentration (ppb)	____________	☐☐☐	4-6
Ambient temperature (degrees celcius)	____________	☐☐	7-8
1. Subject's height (in centimetres)	____________	☐☐☐	9-11
2. Subject's weight (in kilograms)	____________	☐☐☐	12-14
3. Subject's blood pressure	systolic ________	☐☐☐	15-17
	diastolic ________	☐☐☐	18-20
4. Effort number (start)	____________	☐☐☐	21-23
4.1 FeNO measurement (ppb) 1st effort	____________	☐☐☐	24-26
4.2 FeNO measurement (ppb) 2nd effort	____________	☐☐☐	27-29
If there is a discrepancey of > 10 ppb between 1st & 2nd efforts, perform a 3rd effort			
4.3 FeNO measurement (ppb) 3rd effort	____________	☐☐☐	30-32
5. FeNO measurement record attached	Yes (1) No (2)	☐	33

UNIVERSITY OF CAPE TOWN
RISK FACTORS FOR WORK-RELATED ASTHMA IN HEALTH CARE WORKERS WITH EXPOSURE TO DIVERSE CLEANING AGENTS - 2014

CHECKLIST FOR EXPOSURE ASSESSMENT

INTERVIEW WITH THE PERSON IN CHARGE

CHECKLIST NUMBER __________

1. Date Day______Month______Year________

2. Interview done by ____

3. Name of the person interviewed ____

4. Job title: ____

5. Department / Section / Area:

Insert a cross (X) next to the correct answer

OUT-PATIENT CLINICS

____1. Respiratory
____2. Cardiac
____3. GIT
____4. Urology
____5. ENT
____6. Eye
____7. Surgery
____8. Oral & Maxillofacial
____9. Gynae colposcopy

WARDS

____10. ENT ward (F8)
____11. Hemodialysis Lab/ward (E13)

TRAUMA &EMERGENCY

____12. Trauma (C14)
____13. Emergency (C15)
____14. Gynae. Emergency (C24)

OTHER:

____15. ICU, specify ____
____16. Theatre, specify ____
____17. Vascular radiology (C8)
____18. Other, specify: ____

6. How many health care workers are working in this area?
   1. Nurses _____________
   2. Clerks ______________
   3. Cleaners ____________
   4. Porters _____________
   5. Technicians __________
   6. Other ____

7. In the **last 12 months**, has there been an adverse health effect/s reported by your workers related to the cleaning agents? 1. Yes 2. No

IF 'NO' GO TO QUESTION 8
IF 'YES' CONTINUE WITH QUESTION 7.1

7.1. How many health care workers reported these health effects over this period? ______

7.2. What health effect/s were reported by affected workers?

Health effect			No. of events
1. Itchy / red / watery eyes	1. Yes	2. No	______
2. Sneezing / runny / itchy / stuffy nose	1. Yes	2. No	______
3. Itchy throat	1. Yes	2. No	______
4. Wheezing	1. Yes	2. No	______
5. Shortness of breath / chest tightness	1. Yes	2. No	______
6. Cough	1. Yes	2. No	______
7. Itchy skin	1. Yes	2. No	______
8. Redness of the skin	1. Yes	2. No	______
9. Hives ("bommels")	1. Yes	2. No	______
10. Blisters or weeping skin	1. Yes	2. No	______
11. Dry, scaly skin	1. Yes	2. No	______
12. "Collapsed"	1. Yes	2. No	______
13. Other ______			______

7.3. Which cleaning agents were suspected as being responsible for these adverse health effects?

______
______
______
______

7.4. Was there any medical evaluation of these workers who experienced adverse health effects associated with cleaning agents? 1. Yes 2. No

IF 'NO' GO TO QUESTION 8
IF 'YES' CONTINUE WITH QUESTION 7.4.1

7.4.1. How were they evaluated?

1. Referred to GSH Staff Health Clinic	1. Yes	2. No
2. Referred to GSH Occupational Medicine Clinic (E16)	1. Yes	2. No
3. Referred to their own medical practitioner/specialist	1. Yes	2. No

4. Other: ______
______

7.4.2. What were the final outcome/s for these workers?

1. Continued with similar tasks in the same work area	1. Yes	2. No
2. Performed different tasks in the same work area	1. Yes	2. No
3. Work area modified to accommodate the worker/s	1. Yes	2. No
4. Moved to a different work area with different tasks	1. Yes	2. No
5. Resigned/Dismissed due to these health problems	1. Yes	2. No

6. Other ______
______

7.4.3. Are there workers who are not required to work in certain areas because of their preexisting health problems?

1. Yes	2. No

8. In the **last 12 months**, has there been any new cleaning agent/s introduced in this area?

1. Yes	2. No

IF 'NO' GO TO QUESTION 9
IF 'YES' CONTINUE WITH QUESTION 8.1

8.1. Which cleaning agent/s were introduced in this period?

____
____
____

8.2. Why were they introduced? ____

____
____

9. In the **last 12 months**, has there been any cleaning agent/s discontinued from use in this area?

1. Yes	2. No

IF 'NO' GO TO QUESTION 10
IF 'YES' CONTINUE WITH QUESTION 9.1

9.1. Which cleaning agent/s were discontinued from use in this period?

____
____
____

9.2. Why were they discontinued from use? ____

____
____

10. How do you order your cleaning agents?
   1. Through GSH supplies
   2. Outsource/Private/Buyout supplies, specify __________________________________

____

11. Do the workers receive training on how to prepare (diluting, mixing etc.) cleaning agents?

1. Yes	2. No

IF 'NO' GO TO QUESTION 12
IF 'YES' CONTINUE WITH QUESTION 11.1

11.1. How often do the workers receive this training *per year* ? ________________

12. Do the workers receive training on how to use the cleaning agents they work with?/ the actual cleaning/disinfection

1. Yes	2. No

IF 'NO' GO TO QUESTION 13
IF 'YES' CONTINUE WITH QUESTION 12.1

12.1. How often do the workers receive this training *per year* ? ________________

13. Do the workers receive training on how to discard cleaning agents?

1. Yes	2. No

IF 'NO' GO TO QUESTION 14
IF 'YES' CONTINUE WITH QUESTION 13.1

13.1. How often do the workers receive this training *per year* ? ________________

14. Do the workers receive training regarding adverse health effects associated with cleaning agents?

1. Yes	2. No

IF 'NO' GO TO QUESTION 15
IF 'YES' CONTINUE WITH QUESTION 14.1

14.1. How often do the workers receive this training *per year* ? ________________

15. Do the workers working with cleaning agents undergo medical surveillance/ biological monitoring on a regular basis?

1. Yes	2. No

IF 'NO' GO TO NEXT STEP (OBSERVATION)
IF 'YES' CONTINUE WITH QUESTION 15.1

15.1. How often is the biological monitoring conducted on these workers? ________________

15.1.1. Please specify for which cleaning agent ____

15.2. How often do these workers undergo these medical surveillances? ________________

15.2.1. Please specify for which cleaning agent ____

UNIVERSITY OF CAPE TOWN
RISK FACTORS FOR WORK-RELATED ASTHMA IN HEALTH CARE WORKERS WITH EXPOSURE TO DIVERSE CLEANING AGENTS - 2014

CHECKLIST FOR EXPOSURE ASSESSMENT

OBSERVATION

CHECKLIST NUMBER ___________

1. Date Day______Month______Year________

2. Department / Section / Area:

Insert a cross (X) next to the correct answer

OUT-PATIENT CLINICS

____1. Respiratory
____2. Cardiac
____3. GIT
____4. Urology
____5. ENT
____6. Eye
____7. Surgery
____8. Oral & Maxillofacial
____9. Gynae colposcopy

WARDS

____10. ENT ward (F8)
____11. Hemodialysis Lab/ward (E13)

TRAUMA &EMERGENCY

____12. Trauma (C14)
____13. Emergency (C15)
____14. Gynae. Emergency (C24)

OTHER:

____15. ICU, specify ____
____16. Theatre, specify ____
____17. Vascular radiology (C8)
____18. Other, specify: ____

CLEANING / STERILISING MEDICAL INSTRUMENTS

3. In this department, do the workers ***clean, sterilise or conduct high-level disinfection*** of ***medical instruments*** such as bronchoscopes, laryngoscopes, endoscposes, cystoscopes, ***OR metal*** instruments (needle holder, forceps, etc.), ***OR plastic*** instruments such as ear specula for ear examination?

1. Yes	2. No

IF 'NO' GO TO QUESTION 4
IF 'YES' CONTINUE WITH QUESTION 3.1

3.1. Which of the following products are used to ***clean, sterilise*** or to conduct ***high-level disinfection of medical instruments?***

Insert a cross (X) next to the correct answer AND underline a specific product if applicable
Please also insert the appropriate codes where applicable

Products		***In the last 12 months,***		**Spray?**	**Ventila-tion**	**Gloves**		**Respirator**		**Other PPEs**
		Days/week	**Hours/day**				**% of time**		**% of time**	
1. Ortho-phthalaldehydes such as Cidex OPA®, Cidex OPA C	1. Yes / 2. No	________	________	________	______	______	____	________	____	_____
2. Glutaraldehyde such as Cidex®	1. Yes / 2. No	________	________	________	______	______	____	________	____	_____
3. Enzymatic cleaners such as Endozime, or Biozyme	1. Yes / 2. No	________	________	________	______	______	____	________	____	_____
4. Chlorhexidine containing products such as Bioscrub D-germ, Biotane in alcohol or Steriscrub	1. Yes / 2. No	________	________	________	______	______	____	________	____	_____
5. Quaternary ammonium compounds such as MEDDIS	1. Yes / 2. No	________	________	________	______	______	____	________	____	_____
6. Peracetic acid	1. Yes / 2. No	________	________	________	______	______	____	________	____	_____
7. Acetic acid	1. Yes / 2. No	________	________	________	______	______	____	________	____	_____

		In the last 12 months, Days/week	Hours/day	Spray?	Ventilation	Gloves	% of time	Respirator	% of time	Other PPEs
8. Hydrogen peroxide	1. Yes 2. No									
9. Surgislip	1. Yes 2. No									
10. Surgistain	1. Yes 2. No									
11. Alcohols, such as ethyl alcohol 96% (ethanol), isopropanol, methylated spirits, alcohol 50%, or 70%	1. Yes 2. No									
12. Bleach or chlorine, such as Domestos®, Medisure, Biocide D®, or Clorox®	1. Yes 2. No									
13. Bicarbonate concentrate 8.4%	1. Yes 2. No									
14. Citric acid 50%	1. Yes 2. No									
15. Citrosteril	1. Yes 2. No									
16. Renalin 100	1. Yes 2. No									
17. Tiutol KF	1. Yes 2. No									
18. Scop'anios	1. Yes 2. No									
19. Other products ______										
______										
______										

3.2. Which of the following ***tasks*** do the workers perform when ***cleaning, sterilising or*** conducting ***high-level disinfection of medical instruments?***

Tasks	*In the last 12 months,*			Ventila-tion	Gloves		Respirator		Other PPEs
	Days/ week	Times /day	Task dura-tion(hrs)			% of time		% of time	
4. Do the workers ***prepare medical instruments*** for sterilization by ***manually disassembling instruments,*** removing gross contaminants, or flushing ***gros scontaminants and waste?*** 1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
5. Do the workers ***prepare medical instruments*** for sterilization by ***changing sterilization solutions?*** 1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
6. Do the workers ***prepare cleaning solutions*** for example by ***diluting or mixing cleaning agents?*** 1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
7. Do the workers use sterilants immersion container to ***manually sterilize/high-level disinfect*** medical instruments? 1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
8. Do the workers ***sterilize/high-level disinfect*** medical instruments using ***automated systems?*** 1. Yes 2. No									
8.1. If Yes, which system do they operate?									
Cidex OPA system 1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
Other _________________	_____	________	_________	______	______	____	________	____	_____
8.2. Do the workers conduct ***maintenance on the automated system,*** such as cleaning or replacing screens and filters? 1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____

CLEANING FIXED SURFACES, EQUIPMENT OR INSTRUMENTS

10. In this department, do the workers ***clean or disinfect fixed surfaces,*** equipment, or instruments?

Examples of fixed surfaces are: countertops, floors, beds and bathrooms
Examples of equipment are: IV poles, monitors, carts and computers
Examples of instruments are: blood pressure cuffs and stethoscopes

1. Yes	2. No

IF 'NO' GO TO QUESTION 13
IF 'YES' CONTINUE WITH QUESTION 10.1

10.1. Which of the following **products** are used to clean and disinfect ***fixed surfaces, equipment, or instruments?***

Insert a cross (X) next to the correct answer AND underline a specific product if applicable
Please also insert the appropriate codes where applicable

Products		***In the last 12 months,***		**Spray?**	**Ventila-tion**	**Gloves**		**Respirator**		**Other PPEs**
		Days/week	**Hours/day**				**% of time**		**% of time**	
1. Alcohols, such as ethyl alcohol 96% (ethanol), isopropanol, methylated spirits, alcohol 50%, or 70%	1. Yes 2. No	________	________	________	______	______	____	________	____	_____
2. Ammonia, such as Handysan, or Ammonia cleaner (cleaner all purpose)	1. Yes 2. No	________	________	________	______	______	____	________	____	_____
3. Bleach or chlorine, such as Domestos®, Medisure, Biocide D®, or Clorox®	1. Yes 2. No	________	________	________	______	______	____	________	____	_____
4. Utensils cleaning products such as SPARKLE dishwashing liquid, or Liquid soap	1. Yes 2. No	________	________	________	______	______	____	________	____	_____
5. Phenolics, such as MEDIFEN Phenolic disinfectant	1. Yes 2. No	________	________	________	______	______	____	________	____	_____
6. Enzymatic cleaners such as Endozime®, or Biozyme	1. Yes 2. No	________	________	________	______	______	____	________	____	_____
7. Floor wax strippers, such as Multistrip®, or RADICAL Non-ammoniated floor stripper	1. Yes 2. No	________	________	________	______	______	____	________	____	_____

	In the last 12 months, Days/week	Hours/day	Spray?	Ventilation	Gloves	% of time	Respirator	% of time	Other PPEs
8. Floor sealer/wax, such as buff spray (diluted floor sealer/wax), Vision gold®, or Claro-cote® 1. Yes 2. No	______	______	______	______	______	____	______	____	____
9. Glass cleaning products such as Liquid soap, or Windex® 1. Yes 2. No	______	______	______	______	______	____	______	____	____
10. SPARKEM Scouring paste 1. Yes 2. No	______	______	______	______	______	____	______	____	____
11. Air freshener, such as Biocidol disinfectant (Ocean Cherry), air freshener without disinfectant, or DUX 1. Yes 2. No	______	______	______	______	______	____	______	____	____
12. Carpet shampoo 1. Yes 2. No	______	______	______	______	______	____	______	____	____
13. Furniture polish 1. Yes 2. No	______	______	______	______	______	____	______	____	____
14. M4 paste 1. Yes 2. No	______	______	______	______	______	____	______	____	____
15. Stainless steel cleaner 1. Yes 2. No	______	______	______	______	______	____	______	____	____
16. Sumasan 1. Yes 2. No	______	______	______	______	______	____	______	____	____
17. Terrazzo cleaner 1. Yes 2. No	______	______	______	______	______	____	______	____	____
18. Wall cleaner 1. Yes 2. No	______	______	______	______	______	____	______	____	____
19. Washing powder for cleaning floor mops 1. Yes 2. No	______	______	______	______	______	____	______	____	____
20. Other products ______________________	______	______	______	______	______	____	______	____	____
______________________________	______	______	______	______	______	____	______	____	____
______________________________	______	______	______	______	______	____	______	____	____

11. Which of the following **tasks** do the workers perform when cleaning or disinfecting ***fixed surfaces, equipment, or instruments?***

Tasks		***In the last 12 months,***			**Ventila-tion**	**Gloves**		**Respirator**		**Other PPEs**
		Days/ week	**Times /day**	**Task dura-tion(hrs)**			**% of time**		**% of time**	
1. Wipe down beds, furniture, counters, walls, etc.	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
2. Cleanup blood or cleanup other spills	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
3. Manually mix, refill, or empty cleaning or disinfecting products	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
4. Clean bathrooms including toilet, sink, shower	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
5. Spray then wipe glass, windows, mirrors	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
6. Polish wood furniture	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
7. Polish stainless steel surfaces	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
8. Spray deodorant/ disinfectant	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
9. Floor sweeping	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
10. Hoovering / vacuum cleaning	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
11. Rug beating	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
12. Mop floors	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
13. Clean instruments such as scissors, stethoscopes, and thermometers or equipment such as IV poles, carts, monitors, and computers	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
14. Conduct terminal cleaning of patient rooms	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____

		In the last 12 months,			Ventila-tion	Gloves		Respirator		Other PPEs
		Days/ week	Times /day	Task dura-tion(hrs)			% of time		% of time	
15. Use fogging equipment with hydrogen peroxide or peracetic acid vapors to conduct terminal cleaning of patient rooms	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
16. Clean or disinfect for MRSA, VRE or other drug resitant bacteria in patient rooms	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____
17. Conduct end of shift cleaning of operating rooms, dialysis units or other patient care areas	1. Yes 2. No	_____	________	_________	______	______	____	________	____	_____

13. Do the workers use ***more sprays or more wipes,*** or do they use both equally often when cleaning ***fixed surfaces,*** equipment or intsruments?

SELECT THE ONE BEST ANSWER

____1. Use more sprays than wipes ____2. Use more wipes than sprays ____3. Use sprays and wipes about equally

14. Do the workers ***clean and wax floors*** using ***strippers and buffers?***

1. Yes 2. No

IF 'NO' GO TO QUESTION 15
IF 'YES' CONTINUE WITH QUESTION 14.1

14.1. Which ***tasks*** do the workers perform when cleaning and waxing floors using ***strippers and buffers?***

Tasks			In the last 12 months,			Ventila-tion	Gloves		Respirator		Other PPEs
			Days/ week	Times /day	Task dura-tion(hrs)			% of time		% of time	
1. Strip floors	1. Yes	2. No	_____	________	_________	______	______	____	________	____	_____
2. Scrape floors	1. Yes	2. No	_____	________	_________	______	______	____	________	____	_____
3. Buff floors	1. Yes	2. No	_____	________	_________	______	______	____	________	____	_____
4. Wax floors	1. Yes	2. No	_____	________	_________	______	______	____	________	____	_____

USE OF HAND SANITISERS / HAND WASHING PRODUCTS

15. Do the workers use ***liquid hand soaps/sanitisers*** to wash or disinfect their hands?

1. Yes	2. No

IF 'NO' GO TO QUESTION 16
IF 'YES' CONTINUE WITH QUESTION 15.1

15.1. Which of the following products are used for washing/sanitising workers' hands?

Insert a cross (X) next to the correct answer AND underline a specific product if applicable

Products			***In the last 12 months,***		**Spray?**
			Days/week	**Times/day**	
1. Chlorhexidine containing products such as Bioscrub, Steriscrub, D-germ, or Biotane in alcohol	1. Yes	2. No	__________	__________	_________
2. FRESH liquid hand soap	1. Yes	2. No	__________	__________	_________
3. SPARKEM hand soap liquid	1. Yes	2. No	__________	__________	_________
4. Other products ________________________________	1. Yes	2. No	__________	__________	_________
____	1. Yes	2. No	__________	__________	_________
____	1. Yes	2. No	__________	__________	_________

EXPOSURE TO PRODUCTS USED ON PATIENTS

16. Do the workers use ***chemical products on patients?***

1. Yes	2. No

Examples:

Antiseptics *: alcohols, iodine, acetic acid, silver compounds, chlorhexidine, povidone iodine*

Adhesives *: glues, acrylates, bone cements*

Adhesive removing solvents *: alcohols, acetone, ether*

IF 'NO' GO TO QUESTION 17
IF 'YES' CONTINUE WITH QUESTION 16.1

16.1. Which tasks do the workers perform when applying or using ***chemicals, antiseptics, adhesives, alcohols, or solvents on patients?***

Tasks	***In the last 12 months,***			**Ventila-tion**	**Gloves**		**Respirator**		**Other PPEs**
	Days/ week	**Times /day**	**Task dura-tion(hrs)**			**% of time**		**% of time**	
1. Disinfect skin areas on patients prior to ***procedure*** using wipes, gauze or swabs with antiseptics such as Biotane in alcohol, povidone iodine, alcohols, acetic acid — 1. Yes / 2. No	____	________	_________	______	______	____	________	____	_____
2. Clean and disinfect ***wounds*** using antiseptics such as silver compounds, Biotane in alcohol, povidone iodine, or cadexomer iodine — 1. Yes / 2. No	____	________	_________	______	______	____	________	____	_____
3. Apply ***wound dressing*** such as polyurethane based hydrogel, hydrocolloid, or hydrocellular foam — 1. Yes / 2. No	____	________	_________	______	______	____	________	____	_____
4. Use ***adhesives*** such as glues, acrylates, bone cements, benzoin tincture such as Opsite, 3M® Steri-Strip® for surgery, skin closure, bone repair, ostomy bags, and other applications — 1. Yes / 2. No	____	________	_________	______	______	____	________	____	_____
5. Use ***adhesive removing solvents*** such as ether, alcohols or acetone with wipes, gauze, or swabs — 1. Yes / 2. No	____	________	_________	______	______	____	________	____	_____
6. Apply or remove ***synthetic fiberglass casts*** — 1. Yes / 2. No	____	________	_________	______	______	____	________	____	_____

EXPOSURE TO AEROSOLIZED MEDICINES USED ON PATIENTS

17. Do the workers administer aerosolized medications such as bronchodilators or anaesthetics?

1. Yes	2. No

IF 'NO' GO TO QUESTION 18
IF 'YES' CONTINUE WITH QUESTION 17.1

17.1. Which tasks do the workers perform when administering aerosolized medications?

Insert a cross (X) next to the correct answer AND underline a specific product if applicable
Please also insert the appropriate codes where applicable

Tasks			*In the last 12 months,*			Ventilation	Gloves		Respirator		Other PPEs
			Days/ week	Times /day	Task duration(hrs)			% of time		% of time	
1. Administer aerosolized medications with a small volume nebulizer (SVN)	1. Yes / 2. No		____	________	_________	______	______	____	________	____	_____
2. Use continuous aerosol delivery system for bronchodilators and other medicines	1. Yes / 2. No		____	________	_________	______	______	____	________	____	_____
3. Administer aerosolized medications with a metered-dose inhaler (MDI)	1. Yes / 2. No	______	____	________	_________	______	______	____	________	____	_____
4. Administer aerosolized medications with a dry powder inhaler (DPI)	1. Yes / 2. No	______	____	________	_________	______	______	____	________	____	_____

EXPOSURE TO CHEMICALS USED FOR SPECIMEN PREPARATION

18. Do the workers prepare specimes for histology/cytology?

1. Yes	2. No

IF 'NO' GO TO QUESTION 19
IF 'YES' CONTINUE WITH QUESTION 18.1

18.1. Which of the following products are used for specimen preparation?

Insert a cross (X) next to the correct answer AND underline a specific product if applicable
Please also insert the appropriate codes where applicable

Products		*In the last 12 months,*		Spray?	Ventila-tion	Gloves		Respirator		Other PPEs
		Days/week	Hours/day				% of time		% of time	
1. Formalin 10% in normal saline	1. Yes 2. No	___	___	___	___	___	___	___	___	___
2. Fencott cytological fixative spray	1. Yes 2. No	___	___	___	___	___	___	___	___	___
3. Stains and dyes such as hematoxylin and eosin stains	1. Yes 2. No	___	___	___	___	___	___	___	___	___
4. Solvents such as xylene and toluene	1. Yes 2. No	___	___	___	___	___	___	___	___	___
5. Other products ___		___	___	___	___	___	___	___	___	___
___		___	___	___	___	___	___	___	___	___

CLEANING PRODUCTS STORAGE

19. What is the condition of the containers storing cleaning products?

1. Uncovered | 1. Yes | 2. No
2. Partially covered (lid not tightly fitting) | 1. Yes | 2. No
3. Covered with a tight fitting lid | 1. Yes | 2. No

CHEMICAL SPILL / RELEASE

20. Is there any chemical spill or release observed?

1. Yes | 2. No

IF 'NO' GO TO QUESTION 21
IF 'YES' CONTINUE WITH QUESTION 20.1

20.1. If Yes, which chemicals were spilled or released? ______________________________

____

____

ADMINISTRATIVE CONTROLS

21. Which of the following administrative controls are in place for cleaning agents?

Job rotation	1. Yes	2. No
Restricted access to the high exposure areas	1. Yes	2. No
Good house keeping	1. Yes	2. No
Good supervision and management	1. Yes	2. No

22. Is there a Standard Operating Procedures (SOP) document on how to handle cleaning agents? 1. Yes 2. No

IF 'NO' GO TO QUESTION 23
IF 'YES' CONTINUE WITH QUESTION 22.1

22.1. For which cleaning agents? ____
____
____

22.2. Where is it placed?

1. Posted on the wall	1. Yes	2. No
2. Placed in the drawer	1. Yes	2. No

3. Placed elsewhere ____

22.3. When was it last updated? ____

23. Which of the following emergency facilities / items are present in the work area?

1. Emergency showers / eye wash stations	1. Yes	2. No
2. First aid kit	1. Yes	2. No

3. Others ____

AIR MEASUREMENTS FOR OPA

24. Is OPA air measurement indicated in this area? 1. Yes 2. No

UNIVERSITY OF CAPE TOWN

RISK FACTORS FOR WORK-RELATED ASTHMA IN HEALTH CARE WORKERS WITH EXPOSURE TO DIVERSE CLEANING AGENTS - 2016/2017

OPA DATA COLLECTION SHEET 1

WORKER INFORMATION

TO BE COMPLETED FOR EACH WORKER SAMPLED

SURVEY NUMBER __________

Day 1 | Day 2

1. Date Day______Month______Year________ Day______Month______Year________

2. Surname ____________________________________

3. First name/s ____________________________________

4. Gender: ___ Male (1) ___ Female (2)

5. Contact telephone no: Cell _________________________

6. Hand of preference *
   Left (1)
   Right (2)
   No preference (3)

*side where the sampling head should be positioned

7. Department / Section / Area: ____

8. Shift:
   From _____________ to _____________

9. Job title:
   _____ 11.1. Registered nurse
   _____ 11.2. Enrolled nurse
   _____ 11.3. Nurse assistant
   _____ 11.4. Cleaner
   _____ 11.5. Admin staff such as Clerks, etc.
   _____ 11.6. Porter
   _____ 11.7. Technician/technologist, specify: ______________________________________

UNIVERSITY OF CAPE TOWN

RISK FACTORS FOR WORK-RELATED ASTHMA IN HEALTH CARE WORKERS WITH EXPOSURE TO DIVERSE CLEANING AGENTS - 2016/2017

OPA DATA COLLECTION SHEET 2

PASSIVE SAMPLING

TO BE COMPLETED FOR EACH WORKER SAMPLED

SURVEY NUMBER ________________

Day 1

Date: Day______Month______Year________

Temperature: ____________

Humidity: _______________

MONITOR NO.	
START TIME	
END TIME	
DURATION (mins)	
ONE COVER REMOVED	
TWO COVERS REMOVED	

Day 2

Day______Month______Year_______

Temperature: ____________

Humidity: _______________

MONITOR NO.	
START TIME	
END TIME	
DURATION (mins)	
ONE COVER REMOVED	
TWO COVERS REMOVED	

GENERAL COMMENTS:

____
____
____
____
____

UNIVERSITY OF CAPE TOWN
RISK FACTORS FOR WORK-RELATED ASTHMA IN HEALTH CARE WORKERS
WITH EXPOSURE TO DIVERSE CLEANING AGENTS - 2016/2017

OPA DATA COLLECTION SHEET 3

OBSERVATION

TO BE COMPLETED FOR EACH WORKER SAMPLED

SURVEY NUMBER ________________

Date Day______Month______Year________

1. Does the workers ***clean, sterilise or conduct high-level disinfection*** of ***medical instruments*** such as bronchoscopes, laryngoscopes, endoscposes, cystoscopes, ***OR metal*** instruments (needle holder, forceps, etc.), ***OR plastic*** instruments such as ear specula for ear examination? 1. Yes 2. No

IF 'NO' GO TO QUESTION 3 IF 'YES' CONTINUE WITH QUESTION 1.1

1.1. Which of the following ***tasks*** does the worker perform when ***cleaning, sterilising or*** conducting ***high-level disinfection of medical instruments?***

Tasks		Products used for specific task	Task duration (mins)	Times/ day	Days/ week	Ventilation	Gloves	% of time	Respirator	% of time	Other PPEs
1. Does the worker ***prepare medical instruments*** for sterilization by ***manually disassembling instruments,*** removing gross contaminants, or flushing ***gross contaminants and waste?***	1. Yes 2. No										
2. Does the worker ***prepare medical instruments*** for sterilization by ***changing sterilization solutions?***	1. Yes 2. No										
3. Does the worker ***prepare cleaning solutions*** for example by ***diluting or mixing cleaning agents?***	1. Yes 2. No										
4. Does the worker use sterilants immersion container to ***manually sterilize/high-level disinfect*** medical instruments?	1. Yes 2. No										
5. Does the worker ***sterilize/high-level disinfect*** medical instruments using ***automated systems?***	1. Yes 2. No										

2. Which of the following products does the worker use to ***clean, sterilise*** or to conduct ***high-level disinfection*** **of medical instruments?**

Insert a cross (X) next to the correct answer AND underline a specific product if applicable
Please also insert the appropriate codes where applicable

Products		**Spray** (Y=1/N=2)	**Mins/ day**	**Days/ week**	**Products storage**
1. Ortho-phthalaldehydes such as Cidex OPA® or Cidex OPA C	1. Yes 2. No	________	______	_____	________
2. Glutaraldehyde such as Cidex®	1. Yes 2. No	________	______	_____	________
3. Enzymatic cleaners such as Endozime, Biozyme or Sanizyme	1. Yes 2. No	________	______	_____	________
4. Chlorhexidine containing products such as Bioscrub or Steriscrub	1. Yes 2. No	________	______	_____	________
5. Quaternary ammonium compounds such as MEDDIS	1. Yes 2. No	________	______	_____	________
6. Peracetic acid	1. Yes 2. No	________	______	_____	________
7. Acetic acid	1. Yes 2. No	________	______	_____	________
8. Hydrogen peroxide	1. Yes 2. No	________	______	_____	________
9. Surgislip	1. Yes 2. No	________	______	_____	________
10. Surgistain	1. Yes 2. No	________	______	_____	________
11. Alcohols, such as ethyl alcohol 96% (ethanol) isopropanol, methylated spirits, alcohol 50%, or 70%	1. Yes 2. No	________	______	_____	________
12. Bleach or chlorine, such as Domestos®, Medisure , Biocide D®, or Clorox®	1. Yes 2. No	________	______	_____	________
13. Scop'anios	1. Yes 2. No	________	______	_____	________
14. Other products ____________________________		________	______	_____	________
____		________	______	_____	________

<u>Codes for product storage</u>
Uncovered **(1)**
Partially covered (lid not tightly fitting) **(2)**
Covered with a tight fitting lid **(3)**

OTHER CLEANING PRODUCTS USED BY THE WORKER

3. Does the worker use cleaning products for cleaning ***fixed surfaces*** , equipment or instruments? 1. Yes 2. No

IF 'NO' GO TO QUESTION 5 IF 'YES' CONTINUE WITH QUESTION 3 BELOW

Products		Spray (Y=1/N=2)	Mins/day
Fixed surfaces cleaning products			
3.1. Alcohols, such as ethyl alcohol 96% (ethanol), isopropanol, methylated spirits, alcohol 50%, or 70%	1. Yes 2. No	________	________
3.2. Ammonia, such as Handysan, Sumasan or Ammonia cleaner (cleaner all purpose)	1. Yes 2. No	________	________
3.3. Bleach or chlorine, such as Domestos®, Medisure, Biocide D® or Clorox®	1. Yes 2. No	________	________
3.4. Utensils cleaning products such as SPARKLE dishwashing liquid, or Liquid soap	1. Yes 2. No	________	________
3.5. Phenolics, such as MEDIFEN Phenolic disinfectant	1. Yes 2. No	________	________
3.6. Glass cleaning products such as Liquid soap, or Windex®	1. Yes 2. No	________	________
3.7. SPARKEM Scouring paste	1. Yes 2. No	________	________
3.8. Air freshener, such as Biocidol disinfectant (Ocean Cherry), air freshener without disinfectant, or DUX	1. Yes 2. No	________	________
3.9. Carpet shampoo	1. Yes 2. No	________	________
3.10. Furniture polish	1. Yes 2. No	________	________
3.11. M4 paste	1. Yes 2. No	________	________
3.12. Stainless steel cleaner	1. Yes 2. No	________	________
3.13. Terrazzo cleaner	1. Yes 2. No	________	________
3.14. Wall cleaner	1. Yes 2. No	________	________
3.15. Washing powder for cleaning floor mops	1. Yes 2. No	________	________
Floor strippling and waxing products		**Spray** (Y=1/N=2)	**Mins/day**
3.16. Floor wax strippers, such as Multistrip®, or RADICAL Non-ammoniated floor stripper	1. Yes 2. No	________	________
3.17. Floor sealer/wax, such as buff spray (diluted floor sealer/wax) Vision gold®, or Claro-cote®	1. Yes 2. No	________	________

4. Does the worker use ***more sprays or more wipes,*** or does he/she use both equally often when cleaning ***fixed surfaces,*** equipment or instruments?

SELECT THE ONE BEST ANSWER

____1. Use more sprays than wipes ____2. Use more wipes than sprays ____3. Use sprays and wipes about equally

5. Does the worker use ***chemical products on patients?***	1. Yes 2. No		
IF 'NO' GO TO QUESTION 6 — IF 'YES' CONTINUE WITH QUESTION 5 BELOW			
Products for use on patients		**Spray** (Y=1/N=2)	**Mins/day**
5.1. ***Chlorhexidine*** containing products for skin disinfection/wound care such as Biotane in alcohol	1. Yes 2. No	________	________
5.2. ***Iodinated*** products for skin disinfection/wound care such as povidone iodine, cadexomer iodine	1. Yes 2. No	________	________
5.3. ***Silver*** compounds for skin disinfection/wound care such as Flamazine, Silvadene, etc.	1. Yes 2. No	________	________
5.4. ***Alcohols*** with wipes, gauze or swabs for skin disinfection/adhesives removal such as ethyl alcohol 96% (ethanol), isopropanol, methylated spirits, alcohol 50%, or 70%	1. Yes 2. No	________	________
5.5. ***Ether*** for adhesives removal	1. Yes 2. No	________	________
5.6. ***Acetone*** for adhesives removal	1. Yes 2. No	________	________
5.7. ***Adhesives*** such as Opsite, 3M® Steri-Strip® for skin closure, etc.	1. Yes 2. No	________	________
6. Does the worker use chemical products for ***specimen preparation?***	1. Yes 2. No		
IF 'NO' GO TO QUESTION 7 — IF 'YES' CONTINUE WITH QUESTION 6 BELOW			
Products for specimen preparation		**Spray** (Y=1/N=2)	**Mins/day**
6.1. Formalin 10% in normal saline	1. Yes 2. No	________	________
6.2. Fencott cytological fixative spray	1. Yes 2. No	________	________
7. Hand sanitisers/washing products		**Spray** (Y=1/N=2)	**Times/day**
7.1. Chlorhexidine containing hand washing products such as Bioscrub/Steriscrub	1. Yes 2. No	________	________
7.2. Chlorhexidine containing sanitisers such as D-germ or Sterisol	1. Yes 2. No	________	________
7.2. FRESH liquid hand soap	1. Yes 2. No	________	________
8. Other cleaning products		**Spray** (Y=1/N=2)	**Mins/day**
8.1. Other products ____		________	________

OTHER WORKERS PRESENT IN THE SAME AREA / CHEMICAL SPILL OR RELEASE

9. Please mention ***relevant*** cleaning products used by ***other workers*** in the same area (bystander exposures)

Products		**Any spill/release** (Y=1/N=2)
9.1. Ortho-phthalaldehydes such as Cidex OPA®, Cidex OPA C	1. Yes 2. No	________________
9.2. Glutaraldehyde such as Cidex®	1. Yes 2. No	________________
9.3. Formalin 10% in normal saline	1. Yes 2. No	________________
9.4. Enzymatic cleaners such as Endozime or Biozyme	1. Yes 2. No	________________
9.5. Other relevant product/s ____ ____		________________ ________________

Appendix H: Fieldwork pictures

Medical instrument cleaning and disinfection



Fixed surface cleaning

Questionnaire interviews

Blood tests

Exhaled nitric oxide test (FeNO)

Spirometry and methacholine challenge test

Work-Related Asthma Associated with Cleaning Agents in the Health Care Setting - A Review

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Introduction

Previous studies have shown that the proportion of adult asthma cases attributable to occupational exposure is between 10-15% of the population.[1] More recent studies indicate that the population-attributable risk of 10-25% for adult asthma related to occupation exceeds that of previously reported studies.[2,3] Occupational exposure as a cause of adult onset asthma may therefore be more common than is appreciated. In the South African setting, a population attributable fraction of 13% has previously been estimated[4] with occupational asthma ranked as the second most common occupational lung disease after pneumoconiosis.[5]

Health care workers are among the high risk occupational groups for developing work-related asthma (WRA), and accounting for 16% of WRA patients in a US surveillance study.[6] It is well known that natural rubber latex (NRL) has historically been a common cause of WRA in health care workers.[7] Recent studies have reported a decrease in NRL allergy among health care professionals due to substitution with less allergenic alternatives or a reduction in powder and protein content of gloves[8-11] with the incidence of sensitisation to NRL allergens having decreased to 1% in countries that have promoted latex avoidance.[7]

With the global decline in the incidence of NRL allergic asthma, cleaning agents have increasingly been considered a major risk factor for WRA in the health care setting.[11,12] Cleaning agents have been shown to cause work-related asthma-like symptoms, new onset asthma with or without latency and may also exacerbate asthma symptoms in asthmatic individuals.[13] It is estimated that 12% of WRA is related to the use of cleaning products among patients reported in a US surveillance registry.[14] Furthermore, among the causes of work-related reactive airways dysfunction syndrome (RADS), cleaning agents constituted the largest group (15% of the cases) reported by the same surveillance program for WRA.[15]

In population-based studies, workers exposed to cleaning agents have been identified as a high risk occupational group for developing WRA.[16] More specifically, in health care settings, health care workers are required to adhere to strict procedures when performing general cleaning duties including sterilizing medical equipment in order to comply with high infection control standards.[17] As a result, numerous chemicals are being used, some known to be potent respiratory sensitisers and irritants.

The aim of this review is to focus on the recent literature pertaining to WRA associated with cleaning agents in the health care setting.

Search strategy

Several electronic literature sources were searched including PubMed, Google Scholar and Embase for relevant articles using various key words: allergy, asthma, occupational asthma, cleaning agents, cleaning products, disinfectants, chlorhexidine, ortho-phthalaldehyde (OPA), glutaraldehyde (GTA). Reference lists from the articles obtained were also screened for relevant publications.

Epidemiology of asthma related to cleaning agents

Few epidemiological studies have investigated the magnitude of asthma among health care workers (**Table 1**). In an international prospective population-based study [(European Community Respiratory Health Survey-II (ECRHS-II)], Kogevinas et al[2] demonstrated a two-fold (risk ratio (RR) = 2.22; 95% CI: 1.25 to 3.96) increased risk for asthma in nurses compared to a reference group (general population of professional, clerical and administrative workers). In this ECRHS-II study,[2] the prevalence of asthma among nurses was found to be 4.8%.[2] Another ECRHS-II study[18] reported a slightly higher asthma prevalence of 6%, most likely due to different case definitions used for asthma in nurses. This is similar to a US study among health care workers,[10] which demonstrated an overall prevalence of doctor-diagnosed asthma with onset after entry into the healthcare profession to be 6.6%, with the highest prevalence observed among nurses (7.3%) followed by respiratory therapists (5.6%), occupational therapists (4.5%) and doctors (4.2%). However, a recently published study from the same population of health care workers in US reported a much higher prevalence of asthma (9.8%) among nurses.[11] The difference in asthma prevalence between the two studies from the same population is likely to be due to the sampling differences in the two studies. While the earlier study[10] included a total of 941 nurses with active professional licenses, the later study[11] only selected 448 nurses based on their longest job held. Asthma definition was similar in both studies (**Table 1**).

Working populations at risk

Based on occupations in the health care sector, workers considered to be potentially at increased risk include nurses, cleaners, physicians, respiratory therapists and occupational therapists.[11,19–22] Nursing professions typically consist of a number of sub-groups, such as registered nurses, licensed practical nurses, licensed vocational nurses, nurses' aides, nurse practitioners and nurse trainers.[11] Delclos *et al*[10] demonstrated that, among nurses, registered nurses had the highest prevalence of reported asthma (10,2%), followed by licensed vocational nurses (8%) and nurse practitioners and nurse aides (6,9%).

Other studies also demonstrate that cleaners in hospitals also have a higher odds (odds ratio (OR) = 2.1; 95% CI: 1.1 to 4.2) of current asthma when compared to those who have never done a cleaning job or those who were cleaners but had not worked in any listed high risk workplaces (industries, hospitals, kitchens, laboratories, schools, outdoors, private homes, common areas in apartment buildings, other healthcare settings).[22]

Workplace environmental risk factors and causative agents

The extent of exposure to substances in the health care setting for substances other than NRL and its association with WRA is not well characterised. However, there are a few recent studies in the US and Europe that have attempted to address this issue.[17,18] Cross-sectional studies in the US report that aside from powdered latex glove usage (pre-2000), occupational exposure to cleaning substances (e.g. instrument cleaning, surface cleaning) and the use of adhesives / solvents are related to asthma after entry into the health care profession.[10,11]

Potential hazardous workplace activities

Patient care activities performed by nurses include drawing blood, mixing and administering medications, providing wound care and respiratory care, cleaning surgical and non-surgical instruments, mopping floors, assisting with invasive and other medical procedures and assisting with anaesthesia.[11] These activities often involve the handling of chemical products or the release of air contaminants, which may pose a potential health risk.

Population based studies have generally applied a job exposure matrix (JEM) to categorise chemical agents and workplace activities in the health care sector.[2,10,11,23] These studies have identified a number of broad categories of chemical exposures associated with cleaning related activities (e.g. patient care, cleaning and disinfection; instrument cleaning and disinfection; surface cleaning and disinfection); exposure to aerosolized medications such as pentamidine and use of adhesives / solvents (i.e. patient care, on surfaces).[11] Furthermore, accidental chemical exposures and spills may also result in irritant-induced asthma, another sub-group of WRA.[11]

Potential causative agents (asthmagens)

Various studies indicate that the development of occupational asthma is primarily related to the level of exposure to a specific agent in the workplace, and less so to individual host factors such as atopy and smoking, which have produced inconsistent results in a number of studies.[24] Broad groups of potential sensitisers and irritants present in health care settings include surface cleaning products (e.g. bleach); disinfectants and sterilants (e.g. GTA and OPA); adhesives/solvents and hand cleaners (e.g. chlorhexidine); aerosolized medications (e.g. pentamidine); methacrylates in dental and surgical cements; NRL products; micro-organisms and mildew.[6,21,25]

Health care workers are commonly exposed to cleaning products that contain respiratory irritants and sensitisers. Most cleaning agents are irritants however, some cleaning agents have both irritant and sensitizing properties. Some of the known irritants in cleaning agents include chlorine, ammonia, hydrochloric acid, monochloramine, sodium hydroxide, quaternary ammonium compounds (e.g. benzalkonium chloride), monoethanolamine.[13] Sensitisers in cleaning agents include but are not limited to amine compounds (e.g. monoethanolamine), disinfectants (e.g. GTA and OPA), quaternary ammonium compounds, scents (e.g. pinene, d-limonene, eugenol), preservatives (e.g. isothiazolinones and formaldehyde).[13]

Delclos *et al*[10] in their studies of asthma further classified chemical products and agents in the health care sector into three main groups, i.e. instrument cleaning agents, building surface cleaners and adhesives/solvents/gases (**Table 1**). However, while the specific inventories of chemical products used in the health care setting may not always be generalizable across hospitals in different countries, the active ingredients in these cleaning products could be similar across hospitals.

Instrument cleaning/ disinfecting agents

Health care workers, especially nursing personnel, are exposed to cleaning agents used for high-level disinfection of heat sensitive medical equipment such as endoscopes. Of particular importance are the two aldehydes, GTA and OPA. GTA has been used for over 40 years in health care settings not only in disinfection of medical equipment but also as a fixative for electron microscopy and x-ray films. Several clinical case reports have been reported in the literature linking GTA and various health effects such as occupational asthma[26,27] and allergic contact dermatitis.[28] In 1999, Food and Drug Administration (FDA) approved OPA to be used as a high-level disinfectant. Subsequently, OPA has been considered a safer replacement for GTA in some health care settings. However, OPA has also been recently reported to cause occupational asthma[29] and anaphylaxis[30–33] in various case reports, including patients undergoing instrument procedures.

The association between asthma and cleaning agents used for medical equipment disinfection has also been demonstrated in epidemiological studies and surveillance systems. A study by Arif *et al*[11] reported a significantly higher odds of reported asthma among health care workers exposed to medical instrument cleaning agents (adjusted OR = 1.67; 95% CI: 1.06 to 2.62). Six percent of occupational asthma cases reported to a surveillance system in the United Kingdom were attributable to GTA.[34] Although not specified in the article[34] it can be assumed that most, if not all of these cases, were from heath care settings where GTA was commonly used.

Surface cleaning agents

Building surface cleaning is an inherent aspect of activities performed in the health care setting. Cleaners and janitors are widely reported as high-risk occupations in both developed and developing countries.[35–37] In a US surveillance study[14] janitors, cleaners and housekeepers formed the largest (22%) occupational group in which exposure to cleaning products was associated with WRA, followed by a group of nurses and nurses' aides (20%). In this study[14] the health sector had the highest number (39%) of patients with WRA due to cleaning products. While general cleaning tasks have been specifically

Author/year	Population (n)	Prevalence of asthma phenotypes/symptoms	High risk activities significantly associated with asthma OR/RR (95% CI)	Cleaning agents significantly associated with asthma OR/RR/MR (95% CI)	Diagnostic tools used
Arif and Delclos, 2012	Health care workers (n = 3650)	WRAS: 3.3% WEA: 1.1% OA: 0.8%	Not specified	Bleach:3.72(1.70-8.12); cleaners/abrasives: 2.50(1.19-5.25); cleaners for rest rooms and toilets:4.60(2.12-9.95); detergents:2.84(1.33-6.08); ammonia:2.45(1.28-4.69); glutaraldehyde/OPA: 2.18 (1.17-4.07); formaldehyde:2.66(1.03-6.86); Chloramines:4.81(1.28-18.06) and ethylene oxide: 2.97(1.21-7.33)	Questionnaire
Dumas *et al*, 2012	Health care workers (n=724)	Asthma and report of asthma attacks, respiratory symptoms or asthma treatment in the last 12 months: Men: 39.5% Women: 31.6%	General cleaning/ disinfecting tasks: 2.32(1.11-4.86)	Decalcifiers:2.32(1.01-5.31) Ammonia:3.05(1.19-7.82) Sprays:2.87(1.02-8.11)	Questionnaire Expert assessment Asthma-specific JEM
Vizcaya *et al*, 2011	Professional cleaners including hospital cleaners (n=917)	Doctor-diagnosed asthma: 9% Asthma attack in the last 12 months or woken by an attack of shortness of breath in last 12 months or currently taking any medicine for asthma: 11% Asthma with the first asthma attack at the age of 16 years or later: 5%	Hospital cleaners: activities not specified 2.1(1.1-4.2)	Hydrochloric acid:1.7(1.1-2.6); multiple purpose products:1.6(1.0-2.5); ammonia:1.6(1.0-2.5); perfumed products:1.5(1.0-2.4); air fresheners:1.5(1.0-2.4), waxes:1.6(1.0-2.6), degreasers:1.6(1.0-2.4) and carpet cleaners:2.2(1.0-5.1)	Questionnaire
Arif et al, 2009	Health care workers (n=3634)	Doctor-diagnosed asthma with onset after entry into the healthcare profession: 9.8% among nurses BHR-related symptoms: 31.3% among nurses	Medical instrument cleaning:1.67(1.06-2.62) Building surface cleaning:1.72(1.00-2.94)	Adhesives, glues and/or solvents for patient care:1.51(1.08-2.12)	Questionnaire Job exposure matrix
Delclos *et al*, 2007	Health care workers (n=3650)	Doctor-diagnosed asthma with onset after entry into the healthcare profession: Overall: 6.6% Physicians: 4.2% Nurses: 7.3% Respiratory therapists: 5.6% Occupational therapists: 4.5% BHR-related symptoms: overall 27.4%	Medical instrument cleaning:2.22(1.34-3.67) Building surface cleaning: 2.02(1.20-3.40)	Adhesives for patients care:1.65(1.22-2.24) Chemical spills: 2.02(1.28-3.21)	Questionnaire Job exposure matrix
Kogevinas *et al*, 2007	General population (n = 6837)	Asthma attack or taking asthma medication in the past 12 months: 4.8% among nurses	Nursing: activities not specified 2.22(1.25-3.96) Acute symptomatic inhalational event:3.33(1·00-11·13)		Questionnaire Job exposure matrix Expert assessment Methacholine challenge test

Table 1: Recent epidemiological studies on work-related asthma associated with cleaning agents in the health care setting

Table 1 *cont*: Recent epidemiological studies on work-related asthma associated with cleaning agents in the health care setting					
Author/year	**Population (n)**	**Prevalence of asthma phenotypes/symptoms**	**High risk activities significantly associated with asthma OR/RR (95% CI)**	**Cleaning agents significantly associated with asthma OR/ RR/MR (95% CI)**	**Diagnostic tools used**
Mirabelli *et al*, 2007	General population (n = 2813)	Asthma attack in the last 12 months or woken by an attack of shortness of breath in last 12 months or currently taking any medicine for asthma: 6% among nurses	Not specified	Ammonia and/or Bleach: 2.16(1.03-4.53)	Questionnaire IgE test to common aeroallergens
Delclos*et al*, 2006	Health care workers (n=118)	Self-reported history of asthma: 22.9% Prior physician diagnosis of asthma: 20.3% PC_{20} ≤8 mg/ml: 55.1% PC_{20} ≤4 mg/ml: 48.3%	Not specified	Not specified	Questionnaire Industrial hygienist interview Methacholine challenge test IgE test to common aeroallergens IgE test to latex

Key:-
Bronchial hyper-responsiveness (BHR)-related symptoms: combination of eight questions on asthma and allergy symptoms that had exhibited the best combination of sensitivity and specificity when compared to non-specific bronchial challenge testing with methacholine
WRAS (work-related asthma symptom): wheezing or whistling OR shortness of breath at work that gets better when away from work or worsens on return to work
WEA (work exacerbated asthma): wheezing or whistling OR shortness of breath at work that gets better when away from work or worsens on return to work AND physician diagnosis of asthma AND onset of asthma before entry into health care profession
OA (occupational asthma): wheezing or whistling OR shortness of breath at work that gets better when away from work or worsens on return to work AND physician diagnosis of asthma AND onset of asthma after entry into health care profession
PC_{20}: provocative concentration of methacholine that produced a 20% or greater decrease in forced expired volume in one second (FEV_1) from the baseline
JEM: job exposure matrix
IgE: Immunoglobulin E
OR: odds ratio
RR: risk ratio
MR: mean ratio

Table 2: Cleaning agents associated with work-related asthma in health care workers		
Instrument cleaning/disinfection	**Building surface cleaners**	**Adhesive removers and hand cleaners/ disinfectants**
Glutaraldehyde Isopropanol Ortho-phthalaldehyde Sodium sesquicarbonate Subtilisins (enzymatic cleaners)	Acetic acid/acetic acid anhydride Ammonia/ammonium hydroxide Bleach Butyl paraben, ethyl paraben, methyl paraben Diethanolamine Diethylene-glycol n-butyl ether Hydrochloric acid Isoparaffinic hydrocarbons Phosphoric acid Quaternary ammonium compounds Sodium sulfate Sulfuric acid	*Adhesive removers* • Acetone • Dipropylene glycol methyl ether • Ethanol • Isoparaffinic hydrocarbons • Isopropanol *Stoma care products* • Carboxymethyl ether • Hexane-based skin bond • Methylbenzene *Hand cleaners / disinfectants* • Chlorhexidine *Other* • Methylene chloride • Trichloroethane
Source: Modified from reference 10		

linked to asthma,[16,38] cleaners who are at increased risk are often employed in industries other than the health care sector.[9,39]

For general cleaning purposes, Midena-Ramon *et al*[9] found bleach, ammonia and hydrochloric acid as the most commonly used irritant cleaning products used in a diluted or undiluted form, with airborne chlorine and ammonia detected during cleaning activities. A recent study among cleaning workers in Spain reported an increased risk of asthma symptoms in workers who had used hydrochloric acid (mean ratio [MR] = 1.7; 95% CI: 1.1 to 2.6), degreasers (MR = 1.6; 95% CI: 1.0 to 2.4), air fresheners (MR = 1.5; 95% CI: 1.0 to 2.4) or ammonia (MR = 1.6; 95% CI: 1.0 to 2.5) in the last year.[22]

Cleaning agents comprised the most common agent reported (20.5%) among individuals with suspected occupational asthma presenting with acute asthma symptoms to the emergency units of the two large public hospitals in Cape Town.[40] The study by Kogevinas *et al*[2] demonstrated a 1.8 fold (RR = 1.80; 95% CI: 1.01 to 3.18) increased relative risk for asthma with the use of cleaning products (including different occupations and sectors in the analysis). A similar finding was observed among nurses in a study by Arif *et al*[11] that showed a significantly higher odds of reported asthma for exposure to general building cleaning agents and disinfectants (adjusted OR = 1.72; 95% CI: 1.00 to 2.94). According to a large scale European based study, nurses who reported using ammonia and/or bleach were found to have a more than two-fold (RR = 2.16; 95% CI: 1.03 to 4.53) increased risk of developing new-onset asthma compared to referents.[18] An increased relative risk for asthma (RR = 1.51; 95% CI: 1.36 – 1.66) has also been reported among cleaners in the health care setting in Finland.

Apart from the effect of individual agents, some other asthmagens may be produced when different cleaning agents are mixed together.[13] Chloramines may be released when hypochlorite from bleach is mixed with ammonium salts.[13] Chloramines have been reported to cause occupational asthma among pool workers.[41] On the other hand, chlorine, a common respiratory irritant is generated when acid is mixed with bleach.[14]

Application of some cleaning agents can yield high levels of volatile organic compounds (VOC) that can also act as airway irritants.[13] This suggests that there is potential for multiple exposures among workers who are involved in cleaning-related tasks.

Adhesives/solvents and hand cleaners

Pechter et al[6] reported that exposure to solvents accounted for 7% of reported WRA, and various chemicals (including glues and solvents) were associated with asthma among 29% of aides and therapists in the US. Walk-through surveys performed by occupational hygienists in US hospitals revealed that routine patient care activities performed by nurses often included the use of adhesives and adhesive removers, particularly in surgical and intensive care units.[10,11] These compounds are used to apply and/or remove dressings and adhesive bandages, as well in case of stoma care. The compounds may contain respiratory irritants such as dimethyl ether, dipropylene glycol methyl ether and isoparaffinic hydrocarbons, and may be administered in an aerosolized form. Arif *et al*[11] found an almost twofold increased odds of asthma for nursing professionals who were exposed to adhesives, adhesive removers and/or solvents.

A recent study by Nagendran *et al*[42] among health care workers in the wards and operating theatres of a UK district general hospital reported four cases of occupational allergy among 14 health care workers with symptoms associated with the use of chlorhexidine 4% hand wash. However a previous Danish study[43] among 104 health care workers using 0.5–1.0% chlorhexidine hand wash did not identify any cases of chlorhexidine allergy. Although there have been very few reported occupational chlorhexidine IgE-mediated allergic reactions, several case reports exist in the literature of these reactions observed in patients.[42]

Other host-associated risk factors

Common host-associated factors that have been associated with asthma include age, gender, seniority, smoking status and atopy.[10,11] Delclos *et al*[10] demonstrated that increasing seniority was positively associated with reported asthma. The study by Kogevinas *et al*[2] of workers across different industries, demonstrated that atopic individuals had a significantly higher relative risk (RR = 2.9; p-value = 0.019) for new-onset asthma than non-atopics. The study[2] also demonstrated an increased risk for new-onset asthma in participants with a parental history of asthma (RR = 2.1) than those without and in non-smokers (RR = 1.8) compared to current smokers.

Female health care workers appear to be more affected than men. In a recent study[17] among health care workers in the USA, females were found to have a higher prevalence of all asthma phenotypes such as WRA symptoms (3.6% vs. 1.8%), work exacerbated asthma (1.3% vs. 0.3%) and occupational asthma (1.0% vs. 0.1%) than their male counterparts. Similar findings were reported in a large population European study[2] that found a slightly higher relative risk of new-onset asthma among women (RR = 1.13) compared to men. It is likely that the gender distribution of work plays a role.

Pathophysiological mechanisms

The pathophysiology of asthma associated with cleaning agents is not well characterized. It is widely accepted that high molecular weight (HMW) agents, which are commonly proteins such as NRL and proteolytic enzymes cause asthma through immunoglobulin E (IgE)-mediated mechanism.[44] IgE-mediated immunological mechanisms are also believed to play a major role in occupational asthma induced by some low molecular weight (LMW) agents such as acid anhydrides and platinum salts.[44] However, only a small proportion of individuals with occupational asthma due to most LMW agents have specific IgE in the serum suggesting an IgE-independent immunological mechanism (probably involving cell-mediated and mixed Th1 and Th2 responses) may be playing a greater role.[44,45] The mechanism of asthma caused by non-immunological (irritant) mechanisms is not clearly understood. However, it is believed that irritants can destroy bronchial epithelium thereby exposing nerve endings and subsequently trigger a neurogenic inflammation characterized by bronchoconstriction, increased mucus secretion and oedema, which are typical features of asthma.[44,46] It is likely that IgE-independent immunological and irritant mechanisms play a greater role in asthma associated with cleaning agents as most cleaning agents are of LMW.

Some animal and human data are available for common disinfectants such as GTA and OPA. Experimental studies in mice have shown that GTA and OPA are both dermal and respiratory irritants and sensitisers. Interestingly, OPA was found to be more irritant than GTA in both *in vitro* EpiDerm Skin Irritation Test and *in-vivo* tests.[47] The *in vitro* EpiDerm Skin Irritation Test is a test used to assess dermal corrosion potential of chemicals and utilizes a normal, human cell-derived, metabolically active skin model closely mimicking the human epidermis.[47] There was a concentration-dependent increase in lymphocyte proliferation in the draining lymph nodes (DLNs) of the mice in all three studies reported from the US,[47–49] B lymphocytes being the majority in one study.[49] In addition, a population of B lymphocytes expressing IgE was also increased in all these studies, in which mice were exposed to GTA[48] and OPA.[47,49] Another finding supporting the immunological mechanism caused by OPA and GTA was a predominance expression of Th2 cytokines (IL-4, IL-5 and IL-13).[47-49] The two mice studies reported from Japan also demonstrated the production of specific IgE to OPA.[50,51] In the US studies, there was a significantly increase in specific IgE to OPA in mice that were dermally exposed,[47] but they were not detected in those exposed through the inhalational route.[49] Total serum IgE was also elevated in two studies.[47,48]

In some clinical case reports of patients with anaphylaxis due to OPA, skin prick and intracutaneous tests have been used to confirm the presence of sensitisation.[30-33] More importantly, OPA specific IgE was detected by ELISA in all three patients who developed anaphylaxis due to OPA.[32] Furthermore, histamine was released from the basophils of these patients but not from healthy controls.[32] However, when basophils from the healthy controls were sensitized to the patient's serum and then exposed to OPA, these cells also released histamine.[31] This suggests the presence of an OPA specific heat sensitive component (OPA specific IgE) in the patient's serum capable of sensitizing control basophils.[31]

In addition to these immunological data, the clinical history in the case reports of asthma due to OPA and GTA also demonstrated a latency period between first exposure to these agents and development of symptoms implying immunologic response associated with these agents.[32,52] Late reactions were also observed in patients who underwent specific inhalation challenge test to glutaraldehyde, alluding to an underlying allergic mechanism.[52]

Conclusion

With the decline in extensive use of high protein powdered latex gloves, cleaning agents are increasingly becoming a major causative agent of WRA in health care settings. Despite this pattern, cleaning agents continue to be widely used in health care settings globally due to widespread infection control policies. The substitution of one hazardous cleaning agent (GTA) by OPA in various settings has however resulted in OPA increasingly becoming a major risk factor to patients and health care workers.

Future studies need to use more objective measures of exposure assessment and characterization of cleaning agents used in the health care setting. More reliable and valid data can be obtained through a combination of methods including self-reported information from questionnaires, job-exposure matrices, expert judgments and quantitative measurements.

More efforts need to be directed towards conducting mechanistic studies to better understand the pathophysiological mechanisms underlying asthma and other respiratory health effects associated with cleaning agents in health care settings. Elucidation of exposure-response relationships and other host-associated risk factors may contribute towards developing preventive strategies for WRA among health care workers.

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APPENDIX J

Response rates obtained following stratified random sample selection in both hospitals

South African Hospital (SAH)				Tanzanian Hospital (TAH)			
	Study population	Study participants	Response rate (%)		Study population	Study participants	Response rate (%)
Out-patient clinics	104	53	51	Out-patient clinics	72	54	75
Intensive care units	270	107	40	Intensive care units	117	65	56
Operating theaters	205	92	45	Operating theatres	193	117	61
Emergency units	103	36	35	Emergency unit	127	78	61
ENT ward	16	14	88				
Vascular radiology	26	25	96	Central Sterile Services Department	24	22	92
Hemodialysis unit	35	19	54	Hemodialysis unit	27	17	63
Total	759	346	46	Total	560	353	63