

UNIVERSITY OF CAPE TOWN



**DETERMINANTS OF WORK-RELATED SKIN SYMPTOMS AND
DERMATITIS ASSOCIATED WITH CLEANING AGENTS AMONG
HEALTH WORKERS OF TWO TERTIARY HOSPITALS IN
SOUTHERN AFRICA**

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A research report submitted to the School of Public Health and Family Medicine, Faculty of Health Sciences, University of Cape Town in partial fulfilment of the requirement for the award of the degree of Master of Medicine (MMed) in Occupational Medicine

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DECLARATION

Determinants of work-related skin symptoms and dermatitis associated with cleaning agents among health workers of two tertiary hospitals in Southern Africa

I, Zahida Sunday, hereby submit my dissertation for the degree of Master of Medicine (MMed) in Occupational Medicine. I declare that this is my original work (except where acknowledgements indicate otherwise) and that neither the whole work, nor any part of it, has been, is being, or is to be submitted for another degree in this or any other university. This work has not been reported or published prior to registration for the above-mentioned degree.

This dissertation has been submitted to the Turnitin module (or equivalent similarity and originality checking software) and I confirm that my supervisor has seen my report and any concerns revealed by such have been resolved with my supervisor.

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DEDICATION

This dissertation is dedicated to:

- Allah, my Creator, for blessing me with good health, the ability to seek knowledge, and the opportunity to complete this project.
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PUBLICATIONS

Part of this dissertation has been published:

- Sondag Z, Burdzik A, Jeebhay MF. Occupational skin disease in health workers, with a focus on cleaning agents – A review of the literature. *Current Allergy and Clinical Immunology*. 2021; 34(3):179-85

Determinants of work-related skin symptoms and dermatitis associated with cleaning agents among health workers of two tertiary hospitals in Southern Africa

ABSTRACT

Background: Cleaning products and related agents are increasingly associated with occupational irritant and allergic contact dermatitis in health workers (HWs), but limited information is available on predictors for these outcomes.

Objectives: This study investigated the prevalence and risk factors for work-related skin symptoms (WRSS) and skin disease phenotypes in HWs exposed to diverse cleaning agents in two Southern African tertiary hospitals.

Methods: A cross-sectional study of 697 HWs used an interviewer administered questionnaire and assessed the presence of atopy using Phadiatop.

Results: The median age of HWs was 42 years (IQR: 32 – 51), 77.0% were female and 42.5% were atopic. The lifetime prevalence of WRSS was 18.7% and WRSS in the last 12 months was slightly lower (14.8%). Among the skin disease phenotypes, 12.3% had probable contact dermatitis and 3.2% probable contact urticaria. In multivariate regression models, adjusted for family history of allergy and domestic cleaning frequency, technicians (OR_{adj} 4.45, 95% CI: 1.21-21.48) and work activities involving cleaning and disinfection of skin wounds (OR_{adj} 2.70, 95% CI: 1.64-4.57) was associated with WRSS in the past year. A consistent trend was observed for job tasks and cleaning agents related to these work activities. Risk factors for probable contact dermatitis included the use of liquid hand soap (OR_{adj} 1.67, 95% CI: 1.03-2.72), sterilising instruments manually (OR_{adj} 1.94, 95% CI: 1.15-3.19) or automatically (OR_{adj} 3.28, 95% CI: 1.01-9.32), disinfecting skin prior to procedures (OR_{adj} 2.29, 95% CI: 1.45-3.66) and the use of adhesives for wounds (OR_{adj} 1.91, 95% CI: 1.20-3.07). Risk factors for probable contact urticaria included specimen preparation (OR_{adj} 2.65, 95% CI: 1.06-6.38) and wound cleaning and disinfection (OR_{adj} 3.10, 95% CI: 1.24-8.81). Training on protection against adverse health effects of cleaning agents (OR_{adj} 0.54, 95% CI: 0.31-0.89) was protective against WRSS in the past year.

Conclusions: Workplace activities and related factors associated with cleaning and disinfecting of patients' skin and wounds are important risk factors for WRSS in HWs. Training on the adverse health effects of cleaning agents can contribute to decreasing risks in HWs.

Keywords: health workers, skin symptoms, cleaning agents

ABBREVIATIONS AND ACRONYMS

ACD:	Allergic Contact Dermatitis
COVID-19:	Coronavirus Disease of 2019
GTA:	Glutaraldehyde
HW:	Health Worker
ICD:	Irritant Contact Dermatitis
NIOSH:	National Institute for Occupational Safety and Health
NORA:	National Occupational Research Agenda
OCD:	Occupational Contact Dermatitis
OPA:	Ortho-phthalaldehyde
OR:	Odds ratio
OR _{adj} :	Adjusted odds ratio
OSD:	Occupational Skin Disease
PPE:	Personal Protective Equipment
QoL:	Quality of Life
SA:	South Africa
SAHW:	South African Health Worker
SDS:	Skin Disorder Symptoms
TAHW:	Tanzanian Health Worker
WHO:	World Health Organisation
WRSS:	Work-related skin symptoms

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SECTION A: PROTOCOL

DETERMINANTS OF WORK-RELATED SKIN SYMPTOMS AND DERMATITIS ASSOCIATED WITH CLEANING AGENTS AMONG HEALTH WORKERS OF TWO TERTIARY HOSPITALS IN SOUTHERN AFRICA

INTRODUCTION

Background

As the second most common occupational disease after musculoskeletal disorders, occupational skin disease (OSD) is an important cause of morbidity in the general workforce.^{1,2} It is known to result in significant absenteeism and may impair individuals' quality of life (QoL) and prospects of sustaining or progressing their careers.^{3,4} In South Africa OSD is both under-reported and under-diagnosed.^{5,6} This is due to the lack of access to occupational health services and to decisions by workers not to report or treat minor symptoms, but also to occasional misdiagnoses.⁶ It is also under-compensated⁷ as a result of the hidden burden of the condition and significant delays in the compensation process in this country.

OSD includes a broad spectrum of skin conditions which may be induced or aggravated by the workplace, namely: irritant and allergic contact dermatitis (ACD), contact urticaria, nail disorders, leukoderma (loss of skin pigmentation), acne, infections and cancer.¹ According to Kanerva et al,¹ more than 95% of work-related dermatoses are sub-types of contact dermatitis.

Occupations in the healthcare sector are known to pose a high risk for OSD, particularly for occupational contact dermatitis (OCD).^{3,6-12} Natural-rubber latex as a high-risk allergenic agent is becoming less common due to greater awareness of potential latex allergy and the use of less allergenic alternatives or non-powdered low-protein latex gloves.³ Instead, wet work and cleaning agents are increasingly the focus of research on high-risk exposures for OSD in the healthcare sector.^{3,10} During outbreaks of disease such as COVID-19, health workers practise more intensive hand hygiene and surface disinfection, and use a wider range of personal protective equipment (PPE) more frequently and/or for prolonged periods.^{13,14} Increased health worker complaints of PPE-related OSD such as OCD, acne, contact urticaria, erosions and pressure effects have been reported during such outbreaks.^{13,15}

Prevention, early diagnosis and treatment of OSD have been shown to improve outcomes.⁸

Internationally, research on OSD among health workers includes case reports, case series and epidemiological studies of the workforce. Locally available South African studies are case series and case reports (predominantly in tertiary healthcare and insurance or compensation industry settings), but no large-scale epidemiological studies for OSD in health workers have been published. Information gleaned from such studies of health workers in South Africa would provide a better understanding of the local prevalence of OSD in this occupational group, given the challenges of under-reporting and under-diagnosis – even though the studies would be limited to the ‘healthy’ workforce still in employment when only cross-sectional studies are performed. The analysis of the data collected in this way could also serve to assess the association with diverse cleaning agents in a South African context more reliably and explore the risk factors and the specific agents responsible for its development. This would help with implementing targeted prevention strategies and to lower the incidence of OSD in health workers.

Justification

Health workers remain a high-risk occupational group for OSD despite the use of less allergenic alternatives for latex gloves. This is related to cleaning chemicals and cleaning activities such as hand hygiene, the use of protective gloves, surface cleaning and instrument disinfection. These are important considerations to include in occupational health and safety training for health workers so as to broaden knowledge and awareness in an effort to promote safe practices. It is also an important consideration in the safe selection and procurement of cleaning products and PPE such as gloves. An understanding of the prevalence and associated risk factors for work-related skin symptoms and conditions among health workers within a local context was necessary to guide preventive interventions.

Purpose and benefits

This study sought to determine the prevalence of skin symptoms (general and work-related) and work-related skin disease among health workers in Southern Africa and identify risk factors in these health workers. This would enable the identification of appropriate preventive strategies that could be implemented to reduce the incidence of work-related skin disease among health workers and promote safe and healthy work practices.

The insights gained from this study would help improve working conditions to prevent occupational skin disease through:

- promoting awareness on the potential adverse health effects
- informed efforts to reduce cleaning agent exposure with appropriate control measures (e.g., substitution with safer chemical agents / substances, engineering controls like improved ventilation, administrative controls like safe handling protocols, and PPE)
- highlighting the role of occupational health services, inclusive of health risk assessments (qualitative and quantitative) and medical surveillance

Research questions

1. What is the prevalence (12-month period) of skin symptoms in health workers exposed to diverse cleaning agents?
2. What are the risk factors associated with general and work-related skin symptoms in health workers exposed to diverse cleaning agents?

Hypothesis

Occupational factors are associated with an increased risk of work-related skin symptoms, and work-related skin disease, in health workers exposed to diverse cleaning agents. This may be modified by host-associated factors.

Aim

To assess the prevalence and risk factors for skin symptoms in health workers exposed to a variety of cleaning agents in two tertiary hospitals in Southern Africa.

Objectives

1. To describe the baseline demographic, medical, domestic and occupational characteristics of the health worker populations of the two hospitals.
2. To determine the prevalence (12-month period) and distribution (localised and generalised) of general and work-related skin symptoms and doctor diagnosed work-related skin disease.
3. To describe the occupational exposures to cleaning agents in relation to the nature, duration and level of exposure and use of control measures in this population.

4. To identify the host-related and occupational risk factors associated with general and work-related skin symptoms and work-related skin disease, while adjusting for potential confounders.

METHODOLOGY

Study Design

This was an analytical cross-sectional study of health workers. It analysed data from a cross-sectional study performed between 2014 and 2018 in two tertiary academic hospitals in Southern Africa (i.e., South Africa and Tanzania). The original study explored exposure to cleaning agents and reported on the prevalence and risk factors for work-related asthma in this group.¹⁶

Population and sampling

Study population

The World Health Organization (WHO) defines health workers as ‘all people engaged in actions whose primary intent is to enhance health’.¹⁷ This definition includes both health service-providers who directly deliver healthcare services and health management and support workers who are indirectly involved in healthcare.¹⁷ Aligned to this definition, health workers in this study were considered to include both clinical and non-clinical staff categories in the healthcare sector.

A total of 699 health workers participated in the original study, representing an overall response rate of 53% (63% from the Tanzanian hospital and 46% from the South African hospital). Only permanently employed health workers in high-risk departments were included in the study. These high-risk departments were identified through engagement between the investigators and key stakeholders at both hospitals, by means of meetings and walk-through inspections, and included:

- Outpatient clinics, intensive care units, operating theatres, emergency units, and the haemodialysis units at both hospitals
- Ear, Nose and Throat (ENT) ward and vascular radiology department at the South African hospital

- Central sterile services department at the Tanzanian hospital

Doctors were excluded from the original study because the nature of their work made them likely to rotate through multiple different settings with varying exposures, rendering exposure characterization and their association quite onerous.

Of the 699 health workers who participated in the original study, 697 (344 from the South African hospital and 353 from the Tanzanian hospital) completed the questionnaire and were eligible participants for the current study. Inclusion criteria that were applied in this study were:

- Complete information on general skin symptoms was available
- Complete information on work-related skin symptoms was available

Sampling strategy

A list of all staff working in the high-risk departments in both hospitals and eligible for participation in the original study was compiled and constituted the sampling frame in the original broader study. Stratified random sampling according to job title was used to select participants into the original study. Up to 5 health workers with the same job title per department were selected. Where departments had 5 or less health workers per job title, all health workers in that category were chosen to participate. If selected health workers could not participate, they were replaced with another health worker in that category using stratified random sampling again.

Sample size calculations

The original study estimated a sample size of 347 participants for each hospital, based on the sample size calculation for a single proportion, with a mean prevalence of work-related asthma of 6%, expected precision of 0.025 and level of significance (α) 0.05.

The current study used a median one-year period prevalence of 25% computed after considering the findings of previous studies^{9-10,12,18-22} for the anticipated effect size, a combined sample of health workers from both hospitals (697 participants), and a significance level of 0.05. Using these parameters, the power was computed using RStudio® to be greater than 99%.

Measurements

Data collection methods and study instruments

Questionnaire

Selected individuals were approached in their work areas by trained interviewers, who obtained consent for participation. Questionnaires were then administered through private face-to-face interviews (approximately 60 minutes) with the trained interviewers. This was done in English for South African health workers and Swahili for Tanzanian health workers. The questionnaires were validated for repeatability through back-translation.

The questionnaire used was a modified version of the European Community Respiratory Health Survey²³ and included validated questions from the NIOSH questionnaire for cleaning agents in the health care setting²⁴. It gathered information on demographic features, medical history, occupational characteristics, the nature and duration of cleaning agent exposure, workplace control measures and skin and respiratory symptoms. The occurrence of general skin symptoms within the past 12 months was characterised by its distribution (“hands/forearm” or “whole body”) and type / clinical features (“itchy or scratchy skin”, “hives (“bommels”)”, “dry, scaly skin”, “redness of the skin”, “blisters or weeping skin”, “burning skin”, “rash within an hour of contact with a rubber latex product”). The presence of work-related symptoms was further assessed for suspected workplace triggers, with a focus on cleaning agents, and symptoms within the last 12 months.

Completed questionnaire interviews were administered to 697 participants (344 from the South African hospital and 353 from the Tanzanian hospital).

Immunological tests

Approximately 10ml of blood was drawn once-off from 682 participants (339 from the South African hospital and 343 from the Tanzanian hospital) to perform immunological assessments. This included quantification of serum specific immunoglobulin E (IgE) antibodies to commercial preparations of common aeroallergens (Phadiatop). An ImmunoCAP result of > 0.35kU/L was regarded as positive.

DATA MANAGEMENT AND ANALYSIS

List and operational definitions of variables

Table III below provides an overview of the information that was used to generate the variables for the data analysis.

Table III: Predictor and outcome variables

Predictor variables	Outcome variables
<p>Host-related factors:</p> <p>Demographic:</p> <ul style="list-style-type: none"> • Age • Gender (biological sex) <p>Medical:</p> <ul style="list-style-type: none"> • Atopy (positive Phadiatop)* • History of atopic dermatitis • History of allergy to any substance (food/fruit, medication, bites/stings, latex, animals/animal products) • Family history of allergy to any substance <p>Domestic:</p> <ul style="list-style-type: none"> • Frequency of personally cleaning home • Cleaning products exposure <p>Occupational factors:</p> <p>Occupational characteristics:</p> <ul style="list-style-type: none"> • Department • Job title • Employment duration <p>Occupational exposures:</p> <ul style="list-style-type: none"> • Wet work • Workplace activities <ul style="list-style-type: none"> ○ Chemical/cleaning agent ○ Job tasks ○ Duration of exposure ○ Frequency of exposure ○ Protective measures (PPE: glove usage) • Training on adverse health effects • Self-identification of workplace chemical triggers 	<p>General skin symptoms:</p> <ul style="list-style-type: none"> • past history • ≥ 2 episodes in a 12-month period • distribution (localised or generalised) • clinical features of symptoms; urticaria (composite variable 1); probable dermatitis (composite variable 2) <p>Work-related skin symptoms:</p> <ul style="list-style-type: none"> • past history • 12-month period <p>Doctor diagnosed work-related skin disease</p>

All information in this table was derived from the questionnaire, except for the following:

* Immunological assessment (sIgE for Phadiatop)

Predictor variables

The main predictor variables pertain to:

Host-related factors:

- Age
- Gender
- Atopy (Phadiatop immunological test)
- History of atopic dermatitis
- History of allergy to any substance (food/fruit, medication, bites/stings, latex, animals/animal products)
- Family history of allergy to any substance
- Frequency of personal domestic cleaning
- Domestic cleaning agent exposure

Occupational factors:

- Department
- Job title
- Employment duration
 - duration in health work (overall)
 - duration in department
 - previous employment as a health worker (with current employer/within the hospital)
- Self-identification of chemicals causing work-related skin symptoms
- Nature of exposure
 - Wet work exposure (frequency of handwashing)
 - Workplace activity
 - Chemical agent use (by workplace activity)
 - Job task (by workplace activity)
- Duration of exposure (by chemical agent)
- Frequency of exposure
 - by chemical agent
 - by job task
- Glove usage (by job task)
- Administrative controls present
 - Training on adverse health effects due to cleaning agent exposure

Outcome variables

To investigate the outcomes of interest, the following outcome variables were generated using the primary data outlined in Table III above:

- Two or more general skin symptoms in the past 12 months
- Skin symptoms in terms of:

Distribution

- Forearms/hands
- Whole body

Clinical features

- Itchy/scratchy skin
- Hives (“bommels”)
- Dry, scaly skin
- Redness of the skin
- Blisters or weeping skin
- Burning skin
- Rash within an hour of contact with a rubber latex product

Composite skin variables

- Probable urticaria
- Probable contact dermatitis
- Work-related skin symptoms in the past 12 months
- Doctor diagnosed work-related skin disease

Potential confounders

The following potential confounders were considered as covariates in the models:

- Age
- Gender
- Atopy
- History of atopic dermatitis
- History of allergy to any substance
- Frequency of personal domestic cleaning
- Domestic cleaning agent exposure

Data analysis

RStudio® version 3.5.2 2021.09.0+351 "Ghost Orchid" Release (The R Foundation for Statistical Computing 2018) software was used for all analyses. The associations between host-related factors, occupational factors and skin outcomes were investigated. The frequency or distribution of each variable was summarised using univariate analysis. Bivariate analysis with unadjusted logistic regression models was used to assess associations between exposures and outcomes. Multiple logistical regression analysis was used to assess associations between exposures and outcomes, adjusting for confounders (listed above). This information was used to identify possible risk factors.

Dummy tables were created as follows:

- Univariate analysis:
 - Table 1: Host-related and occupational characteristics of health workers working in high-risk areas for diverse cleaning agent exposure
 - Table 2: Occupational exposures and glove usage of SAHWs and TAHWs working in high-risk areas for diverse cleaning agent exposure
 - Table 3: Prevalence of skin symptoms among SAHWs and TAHWs working in high-risk areas for diverse cleaning agent exposure
- Bivariate analysis:
 - Table 4: Association between host-related factors and skin outcomes in unadjusted logistic regression models
 - Table 5: Association between occupational factors and skin outcomes in unadjusted logistic regression models
 - Table 6: Association between occupational exposures and skin outcomes in unadjusted logistic regression models
 - Table 7: Association between self-identification of chemicals causing work-related skin symptoms and skin outcomes in unadjusted logistic regression models
- Multivariate analysis:

- Table 8: Association between occupational factors and skin outcomes in adjusted logistic regression models
- Table 9: Association between occupational exposures and skin outcomes in adjusted logistic regression models
- Table 10: Association between self-identification of chemicals causing work-related skin symptoms and skin outcomes in adjusted logistic regression models

Limitations

A limitation in this study was that no physical examination of participants' skin was performed, nor any patch testing. The potential for information bias therefore exists since the questionnaire relied on self-reported information. Moreover, some information on wet work exposure was not obtained, including the number of glove changes per day or pairs of gloves worn per day, and duration of glove use per day. Another potential limitation is selection bias due to the healthy worker effect, where those who develop work-related illness leave their jobs and those who remain employed are generally healthier. This may lead to a differential probability of inclusion in the study based on disease status, and an underestimation of the true effect.

ETHICS AND COMMUNICATION

Ethics approval was granted for the original study by the Human Research Ethics Committee (HREC) of UCT (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). The data set from the original study was used to perform secondary data analysis. No additional data was collected in this study; therefore, there was no additional risk to the original study participants. The research was conducted in accordance with the principles of the Belmont Report and the Declaration of Helsinki.^{25,26}

Autonomy

Written informed consent was obtained from participants in the appropriate official language prior to enrolment in the original study. Participants were informed that enrolment was voluntary, and they could withdraw at any point. The consent form disclosed necessary

information on risks and benefits (individual and societal) and afforded individuals the autonomy to decide on participation. Potential participants were all formally employed and cognitively competent to consent.

Confidentiality

All study data was coded and bared no personally identifiable information. This data was double password protected and access was only granted to investigators of this study. Original patient records are stored in a locked cupboard at the Division of Occupational Medicine, School of Public Health and Family Medicine, University of Cape Town (UCT) and access to these records is restricted to the investigators of this study. Thus, confidentiality was preserved. For the purposes of public presentations, only summary data will be presented.

Beneficence

For this study, no individual direct benefit will be derived by the participants. However, in the original study, a medical report including the test results was given to participants along with interpretation thereof. In this way, participants were empowered to consult with their own doctors if they experienced any problems or required medical care.

The group benefit of this study is through the enhanced knowledge that will be derived on risk factors for the development of work-related skin symptoms or disease in health workers exposed to diverse cleaning agents. This insight will help improve working conditions to prevent OSD, as outlined in the purpose above.

Non-maleficence

The original study posed minor risks such as potential discomfort answering certain questions and performing non-therapeutic procedures, including a needle prick, potential minor bruise and possible light-headedness. All elements of the study were conducted during working time and considered as time on duty, as arranged with hospital management. Participants provided informed consent and their personal information was kept confidential. The results also showed that no adverse events were reported. Since no new data was collected in this sub-study, no additional medical procedural risks exist.

Justice

The reported burden of occupational skin disease among health workers who are exposed to cleaning agents justifies the need for this study, which will inform measures to reduce the

disease burden and ultimately improve their quality of life. In terms of net risks versus benefits, there was new knowledge to be gained and no additional risks. Considering the agreement principle, any rational participant would agree to the use of the data for this secondary purpose.

Dissemination of research results

This research was conducted for the purposes of an MMed degree. Results will be disseminated through the MMed dissertation, a peer-reviewed publication in an appropriate journal (after it has been examined and comments have been considered), and relevant research / academic forums.

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SECTION B: LITERATURE REVIEW

ABSTRACT

Occupational skin disease is an important cause of morbidity in the global workforce; however, it is often under-diagnosed and under-reported. Health workers are a high-risk occupational group for work-related skin symptoms and conditions when compared to the general working population. Causative agents include both irritants and allergens. While most substances are potential irritants, important risk factors for occupational irritant contact dermatitis in health workers include wet working conditions and cleaning agent ingredients. These include disinfectants such as quaternary ammonium compounds present in surface cleaners and detergent foaming agents such as sodium lauryl sulphate in hand cleansers. With the substitution of less allergenic natural-rubber latex alternatives used in gloves over time, the incidence of latex allergy has declined. Common allergens associated with allergic contact dermatitis in health workers and occasionally implicated in Type-I immediate hypersensitivity reactions include cleaning agents (instrument disinfectants such as glutaraldehyde and ortho-phthalaldehyde, and hand hygiene disinfectants such as chlorhexidine) and glove-related rubber chemicals (especially thiuram). Preservatives and excipients in cleaning agents are also implicated in allergic contact dermatitis.

INTRODUCTION

Occupational skin disease (OSD) is an important cause of morbidity in the general workforce and the second most common occupational disease after musculoskeletal disorders.^{1,2} It is known to result in significant absenteeism and may impair individuals' quality of life (QoL) and prospects of sustaining or progressing their careers.^{3,4} In South Africa OSD is under-reported, under-diagnosed and under-compensated resulting in a hidden burden of disease.⁵⁻⁷

Occupations in the healthcare sector are known to pose a high risk for OSD, particularly for occupational contact dermatitis (OCD).^{3,6-12} Natural-rubber latex as a high-risk allergenic agent is becoming less common due to greater awareness of potential latex allergy and the use of less allergenic alternatives or non-powdered low-protein latex gloves.³ Instead, wet work and cleaning agents are increasingly the focus of research on high-risk exposures for OSD in the healthcare sector and are associated with occupational irritant and/or allergic contact dermatitis in health workers.^{3,10} Prevention, early diagnosis and treatment of OSD have been shown to improve outcomes.⁸

Section B: Literature Review

Internationally, research on OSD among health workers includes case reports, case series and epidemiological studies of the workforce. No comprehensive reviews were found in the published literature which specifically reported on epidemiological data of OSD in health workers globally. There is also a dearth of local epidemiological research on OSD. Locally available South African studies are case series and case reports (predominantly in tertiary healthcare and insurance or compensation industry settings), but no large-scale epidemiological studies for OSD in health workers have been published.

This literature review aimed to assess the prevalence and risk factors for skin symptoms and OSD in health workers exposed to diverse cleaning agents. Host-related risk factors, high-risk occupational characteristics, workplace risk factors and preventive measures were reviewed.

SEARCH STRATEGY

To determine the prevalence of OSD in health workers, a literature search was conducted using the following databases: Pubmed, EbscoHost, Google Scholar, Science Direct and Scopus. Search terms were based on other similar reviews of the topic¹³⁻¹⁵ and included:

- OSD
- occupational dermatoses
- health workers
- risk factors
- cleaning agents
- disinfectants
- aldehydes
- ortho-phthalaldehyde (OPA)
- glutaraldehyde (GTA)
- chlorhexidine
- PPE
- rubber accelerators
- latex allergy.

Based on a pilot research project in South Africa and Tanzania, aldehydes, including OPA and GTA, and chlorhexidine were chosen because they were commonly used in the hospital setting.

Section B: Literature Review

Latex allergy was included as it appeared frequently in the literature on occupational allergies in the healthcare sector. Relevant articles were also identified from the reference lists of articles obtained.

Articles were assessed for their relevance by title and abstract. The articles were also sorted by date (from the most recent) and were accepted if they had been published within the preceding ten years (i.e., 2010–2020), since the last review on the topic was reported in 2014. Full text articles were then reviewed by the researcher and their inclusion was based on the completeness of the reported epidemiological study. Other inclusion criteria were:

- availability in English;
- emphasis on prevalence and risk factors for OSD in health workers;
- OSD in a South African context; and
- cutaneous effects of cleaning agent exposure in health workers.

Articles that looked at workplace-based studies were included, and population-based studies were excluded. Figure 1 is a flow diagram depicting the search strategy.

The authors acknowledge the limitation inherent in using articles that were available only in English, which creates the potential for selection bias.

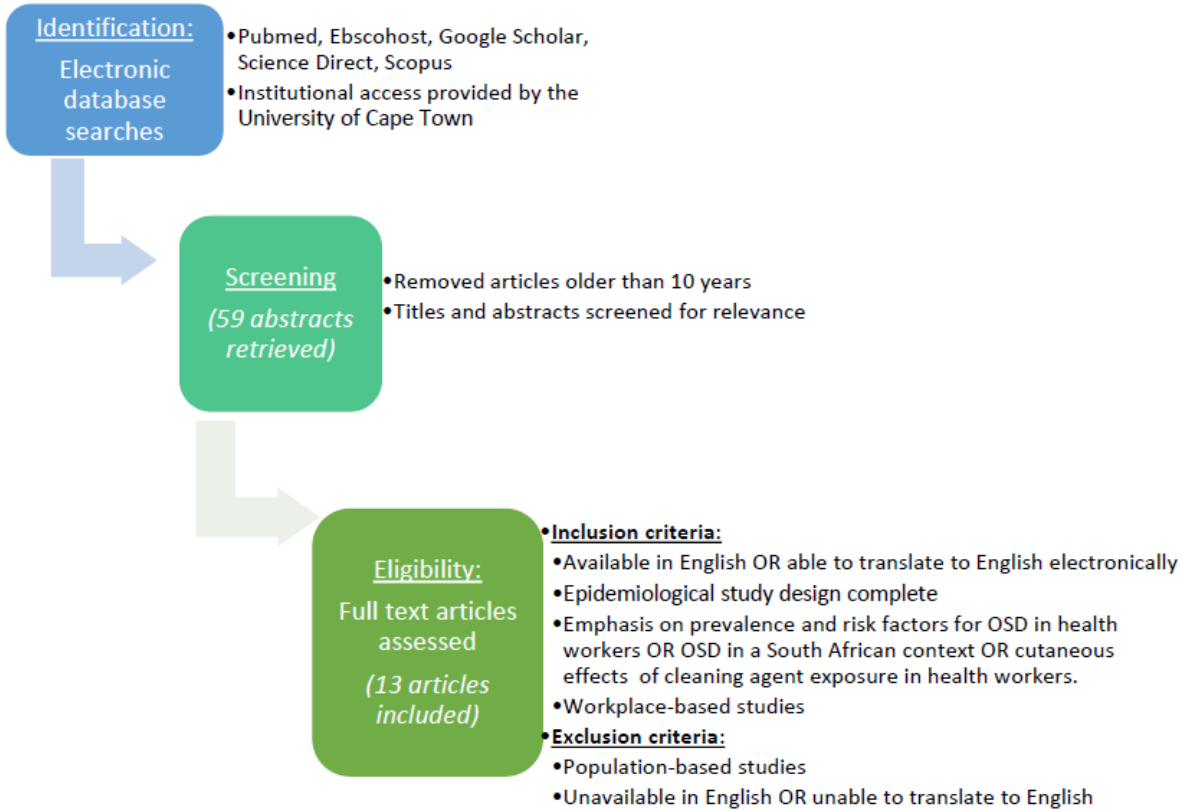


Figure 1: Flow diagram showing the search strategy

PREVALENCE OF OSD ASSOCIATED WITH CLEANING AGENTS

There are few epidemiological studies of OSD in the general population and the data are therefore scarce. Most international data are based on epidemiological studies of defined subsets of occupational groups or on case series and case reports. Definitions of the occupational groups also vary between studies – for example, ‘health workers’ may include those with clinical roles only or all employees working in the healthcare setting. Therefore, drawing comparisons of occurrence of OSD between the general population and health workers is challenging. In addition, the challenges of under-reporting, under-diagnosis and the retention of healthier workers rather than diseased individuals may constitute sources of bias.

Some epidemiological studies of OSD in the general population are noteworthy. In a Swedish study by Meding¹⁶, a one-year prevalence of hand eczema in workers of 11% was found, and a point prevalence of 5.4%. In this study, cleaners had a higher one-year prevalence of hand eczema at 21.3%.¹⁶

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Smit et al¹⁷ conducted a series of surveys on various occupational groups and one on the general population of Netherlands. Here they found an 8.2% one-year prevalence of hand dermatitis in the general population. For OSD, they found a ~30% (28.0%) one-year prevalence of occupational hand dermatitis in the healthcare industry overall. For nurses it was slightly higher (31.6%).

A review of hand eczema in the general population by Thyssen et al¹⁸ found a 4%-point prevalence of hand eczema, 10% one-year prevalence and a lifetime prevalence of approximately 15%.

The epidemiological studies focusing on health workers and skin disorder symptoms identified in the past decade are summarised in Table I. The range for the point prevalence of skin disorder symptoms in health workers globally was between 7% and 30.5% and that for the one-year period prevalence was between 18.9% and 66%. It is evident from the data that while these ranges are very wide, they reflect the potential for a high occurrence of OSD in health workers and cleaners.

No local prevalence studies were found in the published literature. However, in two South African-based case series at tertiary referral centres, health workers were found to be the most frequent occupational group with confirmed OSD reported by Burdzik and Todd (7/31, 23% of the cases were health workers),⁶ whereas health workers were the fourth commonest occupational group reported by Fourie and Carman (15/122, 12% of the cases were health workers).⁷ Similar case series in Brazil and Australia also found that health workers were a commonly affected occupational group.^{19,20} Local and international findings suggest that OCD, both irritant and allergic, was the commonest type of OSD seen.^{6,7,21,22}

Table I: Epidemiological studies of OSD in healthcare in the past decade

Author / year	Population (n)	Prevalence of OSD phenotypes / symptoms	Tasks significantly associated with OSD OR/RR (95% CI) or p-value	Cleaning agents and other exposures significantly associated with OSD OR/RR (95% CI) or p-value	Diagnostic tools used
Point prevalence					
Nichol et al, 2019 ⁸	Health workers in Canada (n = 508)	Hand dermatitis: 30.5%	Wet work (p = 0.024) (No OR reported)	Not specified	Hand Dermatitis Screening Tool (self-/OHNP- administered) Expert assessment of photographs
Alhaji et al, 2018 ⁹	Health workers in Brunei Darussalam (n = 400)	Skin disorder symptoms (SDS): 12%	Clinical role: 2.46 (1.26–4.79)	Contact with SDS-exacerbating materials (including latex gloves, handwashing, topical medicine, disinfectants): 3.73 (1.71–8.14)	Self-administered questionnaire
Gupta et al, 2018 ²³	Health workers in India (n = 710)	Hand eczema: 7.2%	Not specified	Common relevant agents: chlorhexidine, fragrance mix I, formaldehyde, mercaptobenzo-thiazole: (No OR reported)	Self-administered questionnaire Expert assessment Patch testing, if eczema
Schwensen et al, 2016 ²⁴	Health workers and non-health worker controls in Denmark (n = 2 804)	Recruited if contact dermatitis among health workers, OCD: 30.0%	Glove use (thiuram mix) 1.60 (1.10–2.30)	MCI/MI 0.66 (0.44–1.00), MI 0.58 (0.34–0.96)	National database for contact allergy (patch test information included)
Campion et al, 2014 ¹¹	Health workers in the United Kingdom (n = 2 762)	Work-related skin symptoms: Clinical 20% Non-clinical 7%	Handwashing > 20 ×/day (p < 0.01) (No OR reported)	Not specified	Self-administered questionnaire

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Period prevalence					
Barnes et al, 2019 ²⁵	Health workers, in Australia (n = 1 050) Clinical staff 91.3%; non-clinical staff 8.7%	One-year prevalence of symptoms related to chlorhexidine: Symptoms of sensitivity overall 23.8% Dry skin 23.0% Eczema 8% Local rash 9.5% Widespread rash 1.5%	Not specified	Chlorhexidine-based solutions (p < 0.05 for nurses and allied health staff) (No OR reported)	Self-administered questionnaire
Huzaifah and Titi Rahmawati, 2019 ¹⁰	Staff nurses in Malaysia (n = 206)	One-year prevalence of occupational hand contact dermatitis: 26.2%	Glove use (p = 0.001) and wearing gloves > 10 hours/week (p = 0.037) (No OR reported)	Hand wash liquid/soap (p = 0.001) (No OR reported)	Self-administered questionnaire
Alhaji et al, 2018 ⁹	Health workers in Brunei Darussalam (n = 400)	Skin disorder symptoms (SDS): one-year prevalence 19%	Clinical role: At one year: 2.54 (1.46–4.43)	Contact with SDS-exacerbating materials (including: latex gloves, handwashing, topical medicine, disinfectants): At one year: 4.75 (2.41–9.37)	Self-administered questionnaire
Gupta et al, 2018 ²³	Health workers in India (n = 710)	Hand eczema: one-year prevalence 18.9%	Not specified	Common relevant antigens: chlorhexidine, fragrance mix I, formaldehyde, mercaptobenzo-thiazole (No OR reported)	Self-administered questionnaire Expert assessment Patch testing, if eczema
Hamnerius et al, 2018 ²⁶	Clinical health workers in Sweden (n = 474)	History of hand eczema in last 12 months: 66%	Not specified	Concomitant allergy with rubber additives in gloves: fragrances 6.3 (2.3–17.1) preservatives 7.1 (2.8–22.3)	Self-administered questionnaire Patch testing

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		Of the above: OCD 62% ICD 89% ACD 8%			
Hamnerius et al, 2018 ²⁷	Clinical health workers in Sweden (n = 9051)	Hand eczema: one-year prevalence 21%	Wet work and time wearing gloves 1.60 (1.35–1.90)	Wet work and handwashing with soap at work 1.22 (1.07–1.38) Wet work and alcoholic hand disinfectant 1.27 (1.09–1.49)	Self-administered questionnaire
Mekonnen et al, 2018 ¹²	Clinical health workers in Ethiopia (n = 422)	OCD in past 12 months: 31.5% (redness 28.5%, burn 17.3%)	Glove-change frequency 3.22 (2.05–5.87) Handwashing frequency 1.80 (1.10–3.20)	Not specified	Interviewer-administered questionnaire
Ibler et al, 2016 ²⁸	Clinical health workers in Denmark (n = 120)	Recruited if self-reported hand eczema within one year Delayed-type hypersensitivity: 53% Immediate-type hypersensitivity: latex allergy 2.5% Chlorhexidine allergy: < 1%	Not specified	Relevant agents on patch tests: thiuram 5%, fragrance mix I and II 8.3% and 3.3% respectively, MCI/MI 2%, formaldehyde 2%, lanolin alcohols 2% (No OR reported)	Patch tests Prick tests and serology (IgE for latex, chlorhexidine and ethylene oxide)
Callahan et al, 2013 ²⁹	Clinical health workers in the United States (n = 113)	Hand eczema developed at least once in 51.1% of health workers during the six months follow-up	Handwashing frequency (≥ 10 ×/day) 1.55 (1.01–2.39)	Sodium lauryl sulphate 1.87 (1.06–3.31)	Irritant patch testing

Prevalence not specified					
Ibler et al, 2012 ³⁰	Clinical health workers in Denmark (n = 2 269)	Not specified	Handwashing frequency (p < 0.001) Glove use and handling medication (p = 0.014), Phlebotomy (p = 0.019), Handling food articles (p = 0.004) (No OR reported)	Glove use and detergents (p = 0.035) (No OR reported)	Self-administered questionnaire

* Health Workers include clinical and non-clinical staff unless otherwise specified
 OSD – occupational skin disease; OR – odds ratio; RR – risk ratio; CI – confidence interval;
 ICD – irritant contact dermatitis; ACD – allergic contact dermatitis;
 MCI – methylchloroisothiazolinone; MI – methylisothiazolinone

OCCUPATIONS AT RISK

Within occupations in the healthcare sector, those workers performing clinical roles were more commonly affected than those in non-clinical roles.^{9,11} In Brunei Darussalam, Alhaji et al⁹ found a 16% point prevalence of skin disease symptoms in clinical staff and 7% in non-clinical staff ($p = 0.007$). The one-year prevalence was 24.3% in clinical staff and 11% in non-clinical staff ($p < 0.001$).⁹ Huzaifah and Titi Rahmawati¹⁰ found a one-year prevalence of OCD of 26.2% among clinical staff nurses in Malaysia; however, they noted only a 7.7% prevalence in a similar study in Saudi Arabia that recruited clinical and non-clinical staff nurses but did not differentiate between the two categories.³¹ The occupations predominantly affected included nursing and nursing auxiliary staff, medical, dental and surgical staff, allied health staff, technologists and hospital cleaning staff.^{2,23,25}

WORKPLACE RISK FACTORS: CAUSATIVE AGENTS, JOB TASKS AND OCCUPATIONAL ENVIRONMENT

For occupational ICD, wet work was consistently reported as an important risk factor in health workers. Repeated exposure to wet work, along with other irritant exposures, leads to skin-barrier damage exceeding skin-barrier repair which results in ICD. Wet work includes frequent handwashing, performing activities where a large part of the working time is spent with the hands in a wet environment or moist hands due to wearing occlusive/waterproof gloves.³² Important exposure considerations included^{32,33}:

- frequency of wet–dry cycles;
- number of glove changes per day;
- duration of time with wet hands or wearing waterproof gloves;
- ambient temperature;
- relative humidity; and
- hands sweating.

All substances have irritant potential – some are harsh irritants (i.e., corrosives), whereas others are mild irritants. Differences in concentration also affect irritant potential. Some examples are listed below:

- In a case series from Czechia, disinfectants (32%) and cleaning agents (12%) were the predominant substances registered as causative agents for ICD in health workers.³⁴

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- Disinfectant quaternary ammonium compounds such as benzalkonium chloride have been reported frequently in the literature as known irritants associated with ICD but they may sometimes result in ACD.^{35,36}
- Povidone iodine is another chemical that has long been used as a disinfectant agent: current formulations in use for topical application are weakly irritant compared to other disinfectants and it rarely causes ACD.³⁶
- Repeated use of soap and/or detergent hand cleansers are also a risk factor for occupational ICD, more so than alcohol-based hand rubs.³²
- A cohort study by Callahan et al²⁹ found that sodium lauryl sulphate was an important irritant associated with hand eczema in health workers – this is a common detergent foaming agent found in cleaning and hygiene products, including hand cleansers.

Other relevant cleaning agents associated with skin-disorder symptoms in health workers and based on epidemiological studies are shown in Table I. Table II lists the common exposures in cleaning agents and related products that can cause OSD.

Upon sensitisation, occupational allergens may cause ACD (a Type-IV delayed hypersensitivity condition) or contact urticaria syndrome, including protein contact dermatitis (Type-I immediate hypersensitivity condition). Common culprit allergens identified on patch testing and associated with ACD in health workers include:

- glove-related rubber accelerator chemicals (thiurams more so than carbamates, benzothiazoles and guanidines);³⁷
- biocidal preservatives (formaldehyde, formaldehyde releasers, methylchloroisothiazolinone and methylisothiazolinone);¹⁴
- excipients (commonly coconut diethanolamide); and
- disinfectants (including chlorhexidine) in hand cleansers, surgical scrubs and alcohol-based hand rubs.^{3,25}

Table II: Cleaning agents and related products associated with OSD in health workers

High-level disinfectants	Surface disinfectant cleaners	Hand cleaners/surgical scrubs	Cleaning-associated agents and activities	Preservatives and additives in cleaning agents
Glutaraldehyde Ortho-phthalaldehyde (OPA) <i>Less commonly:</i> Hydrogen peroxide Peracetic acid	Quarternary ammonium compounds (including benzalkonium chloride) Ammonia/ammonium hydroxide Sodium hypochlorite	<i>Disinfectants</i> Chlorhexidine Povidone iodine <i>Detergent foaming agents</i> Sodium lauryl sulphate (SLS) <i>Less commonly:</i> Sodium laureth sulphate (SLES) Alkyl polyglucoside (APG) <i>Excipients</i> Coconut diethanolamide	<i>Glove-related rubber components</i> Accelerators (thiurams, dithiocarbamates, benzothiazoles, guanidines, thioureas) Dyes Hev b sensitising latex proteins <i>Water (wet work)</i>	<i>Preservatives</i> Formaldehyde Formaldehyde releasers (including quaternium 15, diemthyloldimethyl [DMDM] hydantoin, imidazolidinyl urea [IMID], diazolidinyl urea, bronopol, parabens) Methylchloroisothiazolinone (MCI) Methylisothiazolinone (MI) <i>Additives</i> Fragrance

Sources: References^{3,14,35-39}

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Natural-rubber latex is usually associated with Type-I immediate hypersensitivity reactions and is becoming less of a concern, as described earlier. The incidence of sensitisation to natural-rubber latex has decreased to 1% in countries that have implemented avoidance measures.⁴⁰ As reported by Mwangi⁴¹, the global prevalence of natural rubber latex allergy among health workers ranged from 3-31% and the South African prevalence ranged from 5-21%. More recently, Type-I immediate hypersensitivity and Type-IV delayed hypersensitivity have been reported following exposure to disinfectants such as aldehydes (e.g., glutaraldehyde⁴² and ortho-phthalaldehyde (OPA)⁴³ used to disinfect medical instruments) and chlorhexidine gluconate used in hand-hygiene products and dental solutions.^{27,44} It is noted that hypersensitivity reactions upon exposure to these agents ranged from local to generalised skin reactions, respiratory or other systemic reactions and even anaphylaxis.^{36,43,45} Owing to concerns about glutaraldehyde toxicity, OPA and combinations of hydrogen peroxide and peracetic acid were introduced as safer high-level disinfectant options.³⁸ However, when Anderson et al⁴⁶ compared the irritant and allergy potential of glutaraldehyde and OPA induced by topical application, they found that OPA had more skin irritancy and allergenicity than glutaraldehyde. The agents causing Type-I hypersensitivity skin conditions are generally both dermal and respiratory sensitisers.^{42,43}

A lack of health and safety training on cleaning agents and hand hygiene together with the lack of safe-use protocols for high-level disinfectants which are used to eliminate most micro-organisms on medical instruments were found to be risk factors for OCD.¹² Mekonnen et al,¹² in their study of health workers in Ethiopia, found that a lack of health and safety training was associated with an increased risk of developing OCD (AOR 2.12 [95% CI 1.12, 2.25]). The implementation of an appropriate health and safety training programme is therefore an important protective measure for reducing the risk of OCD.

Control measures are also important in reducing exposure to occupational hazards. The study of Henn et al⁴⁷ on the precautionary practices and use of PPE of approximately 4 000 health workers in the United States using high-level disinfectants found that 44% did not wear water-resistant gowns, 9% did not wear protective gloves, 12% reported skin contact and 17% lacked safe-handling training.⁴⁷

Avoiding prolonged glove-wearing times and changing gloves frequently are also recommended: glove wearing > 10 hours/week ($p = 0.037$)¹⁰ or > 3 hours/day (OR 1.60 [95%

CI 1.35, 1.90]) was associated with hand dermatitis²³; wearing > 5 pairs gloves/day was associated with OCD (AOR 3.22 [95% CI 2.05, 5.87]).¹²

HOST-RELATED RISK FACTORS

The prevalence of ICD in health workers was found to be inversely proportional to age, with lower prevalence in older age groups.⁸ It is noted, however, that the study participants were possibly those who had been in the occupation for longer and would be less likely to have disease due to the ‘healthy worker’ effect (a type of selection bias due to people remaining in employment being healthier than those who are unemployed). There was generally a higher occurrence of ICD in women,⁹ but this is probably due to the gendered distribution of work. A personal history of atopy⁷ and of atopic dermatitis^{8,9,11} were also risk factors for ICD only. A history of allergy (immediate or delayed-type hypersensitivity) to any substance (including food, medication, metals and animal fur) was found to be a risk factor for OCD (ACD or ICD).^{10,12}

PREVENTION

The occupational health and safety hierarchy of control measures should be applied in healthcare facilities as a framework to implement suitable prevention measures. The Cleaning and Disinfecting in Healthcare Working Group formed by the American National Institute for Occupational Safety and Health (NIOSH) and involving four countries, and the American National Occupational Research Agenda (NORA), provide international recommendations for an integrated and safe approach to environmental cleaning and disinfection in healthcare.⁴⁸ Substituting safer alternatives must be considered when selecting products. Engineering controls such as adequate room size and ventilation must be available when using hazardous chemicals.⁴⁸ Administrative control measures must include⁴⁸:

- regular health risk assessments;
- training in the safe use of products and PPE;
- communicating hazards to all stakeholders; and
- accurate labelling of products with appropriate safety warnings.

Safety data sheets must be available for all chemical products used, listing all ingredients and relevant safety precautions. It should be remembered, however, that contaminants may be present in these products which would not be listed on the safety data sheet, and these may

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often vary within different batches. Other protective measures include the procurement of cleaning agents containing proven safer ingredients – for example, sodium laureth sulphate or alkyl polyglucoside instead of the harsher irritant sodium lauryl sulphate.³⁹

The use of protective gloves to prevent skin contact when handling known irritant or allergenic substances and preventing dirty hands will reduce the need to wash hands frequently with soap and water.³² Instead, alcohol-based hand disinfectants could be used when hands are not visibly soiled as they are less irritant than frequent handwashing and using detergents.^{32,49} The use of cotton gloves underneath rubber gloves may be considered to prevent the skin from becoming wet when prolonged glove-wearing times are required. If prolonged glove-wearing times and frequent glove changes are unavoidable, adopting skin-care measures is important. The use of moisturisers after handwashing as part of integrated skin care, including milder skin cleaning, is useful in maintaining skin barrier function and preventing OSD.^{11,32}

Given the complex mixtures of cleaning agents used, PPE selection can be challenging.⁴⁸ PPE selection must be based on the specific products and cleaning practices in use, as guided by the risk assessments and safety data sheets.⁴⁸ Generally, handling high-level disinfectants such as glutaraldehyde or ortho-phthalaldehyde solutions requires the use of protective gloves (e.g. nitrile), impervious clothing (e.g. plastic apron or gown) and eye protection (e.g. goggles with side-shields).^{50,51} Wearing protective gloves is also advised when using surface disinfectants.

Safer glove alternatives should be considered, including powder-free low-protein latex gloves or preferably latex-free gloves, and rubber accelerator-free gloves – for example, nitrile accelerator-free, polychloroprene, polyisoprene or thermoplastic elastomer gloves.³⁷

In their analysis of various suppliers' natural-rubber latex gloves used in South Africa, Mabe et al⁵² found that none of the 14 types (powdered and non-powdered) met the criteria for low allergenicity with a total allergen content less than the suggested threshold limit (< 0.15 µg/g). Similarly, Ratshikhopa et al⁵³ found that only four of the 20 (20%) natural-rubber latex glove types used in South Africa and analysed in their study were below this threshold. The quality and latex content of gloves are important criteria to consider in procurement processes for gloves and procurement officers should therefore be aware of locally available testing for the latex concentration and allergenicity of gloves to prevent OSD.⁵³ However, there is no

universal glove type which suits all requirements and glove choices should be based on multiple factors apart from allergenicity, including tasks and hazard exposure.

Screening (as part of medical surveillance⁴⁸) may identify OSD at an early stage when there are relatively minor symptoms, and an intervention then is more likely to be successful in controlling the condition and the resultant impairment. Medical surveillance of health workers in high-risk roles or performing high-risk tasks using cleaning agents, as a secondary prevention measure, is recommended for early disease detection and the prevention of serious health outcomes.⁵⁴ Questionnaire interviews, physical examination and appropriate immunological testing are useful tools in the surveillance of these health workers.⁵⁴

CONCLUSION

OSD is an important cause of morbidity globally and health workers are a high-risk occupational group for work-related skin symptoms and conditions compared to the general working population. Across multiple studies, the point and 1-year period prevalence of OSD in health workers displays a higher upper range limit compared to the general population. According to the literature, potential host-related risk factors include age, gender, atopy, history of atopic dermatitis and history of allergy to any substance. Occupational risk factors include occupation (clinical role), causative agents (commonly disinfectants), job tasks (such as wet work) and occupational environment (as controlled by risk mitigation measures). There is an absence of studies on risk factors in resource-constrained environments, high-risk work practices/tasks like patient's wound cleaning and skin disinfection, specific chemical agent categories involved and on dose-response relationships. Considering the lack of local epidemiological studies on OSD, future studies should focus on the important research gaps identified including the local prevalence of work-related skin symptoms and dermatitis in health workers in Southern Africa, and the associated host-related and occupational risk factors in this context. Specifically, research on occupational risk factors in these health workers must involve more detailed information on high-risk occupational roles; high-risk areas within healthcare facilities; the nature (i.e., significant cleaning agents, workplace activities and tasks), frequency and duration of exposure; and the role of dermal personal protective equipment such as gloves in reducing the risk of work-related skin disease.

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Section B: Literature Review

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SECTION C: JOURNAL MANUSCRIPT

This manuscript has been prepared to be submitted for publication in the journal, Contact Dermatitis. The format of the article follows the journal's guidelines for authors (Appendix 6).

Determinants of work-related skin symptoms and dermatitis associated with cleaning agents among health workers of two tertiary hospitals in Southern Africa

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Ethical statement

Ethical approval for this study was provided by the Human Research Ethics Committee (HREC) of the University of Cape Town (HREC Ref: 811/2021).

Conflict of interest

There is no conflict of interest to declare.

Data sharing

Data available on request due to privacy/ethical restrictions.

Funding

No funding was provided for this study.

ABSTRACT

Background: Cleaning products and related agents are increasingly associated with occupational irritant and allergic contact dermatitis in health workers (HWs), but limited information is available on predictors for these outcomes.

Objectives: This study investigated the prevalence and risk factors for work-related skin symptoms (WRSS) and skin disease phenotypes in HWs exposed to diverse cleaning agents in two Southern African tertiary hospitals.

Methods: A cross-sectional study of 697 HWs used an interviewer administered questionnaire and assessed the presence of atopy using Phadiatop.

Results: The median age of HWs was 42 years (IQR: 32 – 51), 77.0% were female and 42.5% were atopic. The lifetime prevalence of WRSS was 18.7% and WRSS in the last 12 months was slightly lower (14.8%). Among the skin disease phenotypes, 12.3% had probable contact dermatitis and 3.2% probable contact urticaria. In multivariate regression models, adjusted for family history of allergy and domestic cleaning frequency, technicians (OR_{adj} 4.45, 95% CI: 1.21-21.48) and work activities involving cleaning and disinfection of skin wounds (OR_{adj} 2.70, 95% CI: 1.64-4.57) was associated with WRSS in the past year. A consistent trend was observed for job tasks and cleaning agents related to these work activities. Risk factors for probable contact dermatitis included the use of liquid hand soap (OR_{adj} 1.67, 95% CI: 1.03-2.72), sterilising instruments manually (OR_{adj} 1.94, 95% CI: 1.15-3.19) or automatically (OR_{adj} 3.28, 95% CI: 1.01-9.32), disinfecting skin prior to procedures (OR_{adj} 2.29, 95% CI: 1.45-3.66) and the use of adhesives for wounds (OR_{adj} 1.91, 95% CI: 1.20-3.07). Risk factors for probable contact urticaria included specimen preparation (OR_{adj} 2.65, 95% CI: 1.06-6.38) and wound cleaning and disinfection (OR_{adj} 3.10, 95% CI: 1.24-8.81). Training on protection against adverse health effects of cleaning agents (OR_{adj} 0.54, 95% CI: 0.31-0.89) was protective against WRSS in the past year.

Conclusions: Workplace activities and related factors associated with cleaning and disinfecting of patients' skin and wounds are important risk factors for WRSS in HWs. Training on the adverse health effects of cleaning agents can contribute to decreasing risks in HWs.

Keywords: health workers, skin symptoms, cleaning agents

INTRODUCTION

Occupational skin disease (OSD) is an important cause of morbidity in the global workforce; however, it is often under-diagnosed and under-reported.^{1,2} Health workers (HWs) are a high-risk occupational group for work-related skin symptoms (WRSS) and conditions compared to the general working population.²⁻⁶

Global epidemiological studies have reported the prevalence of skin-related symptoms in the past year in HWs of between 18 – 66%.⁷ This was higher than the one-year prevalence of hand dermatitis in the general population (8.2 – 11%).⁸⁻¹⁰ In a recent review, associations were observed between OSD or skin symptoms, mostly attributable to contact dermatitis in HWs, and various occupational and host-related factors.⁷

Host-related risk factors included younger age, female sex, a personal history of atopy and atopic dermatitis.⁷ It has been suggested that the healthy worker effect and gendered distribution of work may have impacted the age and gender relationships, respectively.⁴ A history of allergy to any substance was identified as a risk factor for OSD (allergic contact dermatitis [ACD] or irritant contact dermatitis [ICD]).^{11,12} The occupations commonly affected included those HWs in clinical roles such as nursing and nursing auxiliary staff, medical, dental and surgical staff, allied health staff, technologists and hospital cleaning staff.^{2,13,14}

Workplace risk factors for OSD identified included cleaning agents, job tasks involving wet work, and a lack of health and safety training.^{7,12,15,16} Preventive measures such as the use of alcohol-based hand disinfectants instead of handwashing when hands are not visibly soiled^{15,17}, and safer glove options such as powder-free low-protein latex gloves or latex-free gloves have also been reported to reduce the risk of OSD^{18,19}.

Causative agents for OSD in the health care setting commonly include both irritants and allergens. Aside from wet working conditions, cleaning agent ingredients are a major cause of ICD.²⁰ These include disinfectants such as quaternary ammonium compounds present in surface cleaners and detergent foaming agents such as sodium lauryl sulphate in hand cleansers.²¹⁻²³ With the substitution of less allergenic natural-rubber latex alternatives used in gloves over time, the global incidence of latex allergy has declined.²⁴ Common allergens associated with ACD in HWs and occasionally implicated in Type-I immediate hypersensitivity reactions include cleaning agents (instrument disinfectants such as glutaraldehyde [GTA] and ortho-phthalaldehyde [OPA], and hand hygiene disinfectants such

as chlorhexidine) and glove-related rubber chemicals (especially thiuram).^{2,14,25} Preservatives and excipients in cleaning agents are also implicated in ACD.²⁶

A dearth of epidemiological studies exists on the prevalence and predictors of WRSS in HWs in the local health care setting. This study aimed to assess the prevalence and risk factors for skin symptoms in HWs exposed to a variety of cleaning agents in two tertiary hospitals in Southern Africa.

METHODS

Study design, population and sampling

A cross-sectional analytical study of HWs was conducted. It analysed data from a larger study collected between 2014 and 2018 in two tertiary academic hospitals in Southern Africa (i.e., South Africa [SA] and Tanzania). The original study explored exposure to cleaning agents and reported on the prevalence and risk factors for work-related asthma in this group.²⁷

A total of 699 permanently employed HWs working in high-risk departments were included in the larger study. These potentially high-risk departments were identified through engagement between the investigators and key stakeholders at both hospitals, by means of meetings and walk-through inspections. Doctors were excluded since the nature of their work resulted in them frequently rotating through multiple different settings with varying exposures, rendering exposure characterization and their association quite onerous.

For the current study, all 697 HWs (344 from the SA hospital and 353 from the Tanzanian hospital) that completed the questionnaire and had complete information on general and work-related skin symptoms were included.

Sampling strategy

A list of all staff working in the high-risk departments in both hospitals and eligible for participation in the original study was compiled and constituted the sampling frame. Stratified random sampling according to job title was used to select participants into the original larger study. Up to 5 HWs with the same job title per department were selected. Where departments had 5 or less HWs per job title, all HWs in that category were chosen to participate. If selected HWs could not participate, they were replaced with another HW in that category using stratified random sampling. The overall response rate was 53%, with a higher response rate among Tanzanian health workers (TAHWs) (63%) compared to the South African health workers (SAHWs) (46%).

Health outcome assessments

Questionnaire

A total of 697 participants completed interviewer administered questionnaires. This was administered in English for SAHWs and in Swahili for TAHWs. The questionnaires were validated for repeatability through back-translation.

The questionnaire used was a modified version of the European Community Respiratory Health Survey²⁸ and included validated questions from the National Institute for Occupational Safety and Health questionnaire for cleaning agents in the health care setting²⁹. It gathered information on demographic features, medical history, occupational characteristics, the nature and duration of cleaning agent exposure, workplace control measures and skin and respiratory symptoms. The occurrence of general skin symptoms within the past 12 months was characterised by its distribution (“hands/forearm” or “whole body”) and type / clinical features (“itchy or scratchy skin”, “hives (“bommels”)”, “dry, scaly skin”, “redness of the skin”, “blisters or weeping skin”, “burning skin”, “rash within an hour of contact with a rubber latex product”). The presence of WRSS was further assessed for suspected workplace triggers, with a focus on cleaning agents, and symptoms within the last 12 months.

Immunological tests

Approximately 10ml of blood was drawn once-off from 682 participants (339 working in the South African hospital and 343 from the Tanzanian hospital) for quantification of immunoglobulin E (IgE) to common aeroallergens (Phadiatop). An ImmunoCAP result of >0.35kU/L was regarded as positive.

Operational definitions

Health workers (HWs): HWs included both clinical and non-clinical staff categories in the healthcare sector according to the WHO definition.³⁰

Probable contact urticaria: Two or more skin symptoms in the last 12 months, affecting hands or generalised and one of hives, or rash within 1 hour of contact with a rubber latex product.

Probable contact dermatitis: Two or more skin symptoms in the last 12 months, affecting hands with itchy/scratchy skin, or dry/scaly skin, or redness of the skin, or blisters/weeping skin, or burning skin.

Definition 1 – Work-related skin symptoms in the past year: A sensitive definition where HWs experienced WRSS at work any time within the last twelve months.

Definition 2 – Work-related skin symptoms in the past year: A more specific definition where HWs experienced WRSS that improved away from work or worsened on return to work within the last twelve months.

Data analysis

RStudio (URL: <http://www.rstudio.com/>), RRID:SCR_000432 was used for all analyses. The prevalence of the exposures and skin outcomes, (which included WRSS, probable urticaria, and probable contact dermatitis) was computed and compared between the two hospitals. Bivariate analysis with unadjusted logistic regression models was used to assess associations between host-related (e.g., age, gender, atopy, personal or family history of allergy, and domestic cleaning habits) and occupational factors (e.g., work activities and tasks, cleaning agents, glove usage and training) in relation to the skin outcomes. The following potential confounders were considered a-priori: age, gender, atopy, history of atopic dermatitis, history of allergy to any substance, frequency of personal domestic cleaning, and domestic cleaning agent exposure. Multivariate saturated logistic regression models were developed and adjusted for family history of allergy and personal domestic cleaning for more than once per week, because significant associations were observed between these exposures and skin outcomes. A second set of multivariate logistic regression models adjusting additionally for age, gender and atopy were developed but it did not result in differences in the effect estimates. A personal history of allergy to any substance was not adjusted for since it was highly correlated with HWs who self-identified latex as a cause of their WRSS.

RESULTS

Study population

The host-related and occupational characteristics of the 697 study subjects are presented in Table 1 and stratified by the hospital in which they were employed.

The median age of participants was 42 years, and a large proportion were female (77.0%) with a median employment duration of 14 years. The prevalence of atopy was 42.5%, but a much lower prevalence of a personal history of atopic dermatitis (3.2%) was reported.

Most of the participants personally cleaned their own homes more than one day per week, which was more prevalent among SAHWs (95.1%) than TAHWs (77.6%). SAHWs commonly used ammonia-based agents (89.8%) and chlorine-based products (78.5%) compared to only 23.2% of TAHWs that used chlorine-based products.

The commonest departments in which study subjects were employed were operating theatres (OTs) (29.8%) and intensive care units (ICUs) (24.8%). The majority of participants (75.5%) were nursing professionals (registered professional nurses [40.6%], nurse assistants [24.1%] and enrolled nurses [10.8%]), followed by cleaners (12.2%).

SAHWs were generally working in health care for a longer duration (median 20 years) than their TAHW counterparts (median 11 years). Despite the significant difference in employment duration in health work between SAHWs and TAHWs, the median duration of employment in the current department for all HWs was 4 years.

Overall, SAHW's were significantly older with a higher reported prevalence of atopy, family history of allergy, atopic dermatitis and domestic chemical use. However, TAHW's reported a higher prevalence of history of allergy (including insect bites or stings, foods, medication, or latex).

Skin symptoms

Skin symptoms in the past 12 months were present in 17.9% of HWs and was more common among SAHWs at 23.8%, compared to 12.3% in TAHWs (Table 2). The three most prevalent localised symptoms were itching or scratchiness (10.3%), redness (6.5%) and burning skin (3.4%) affecting the hands. The prevalence of probable contact urticaria was 3.2% and probable contact dermatitis was 12.3%.

A total of 130 participants (18.7%) encountered WRSS in their lifetime, 14.8% reported WRSS within the last 12 months (definition 1), and 11.5% reported more specific WRSS within the last 12 months (definition 2). Very few participants reported doctor-diagnosed work-related skin disease (2.9%). Due to this low prevalence, further associations with this outcome could not be explored.

Participants self-reported chlorhexidine (15.7% of SAHWs), latex (2.7%), bleach (2.4%), liquid soap (1.6%) and OPA (1.0%) as the top five chemical triggers for their skin symptoms. Notably, TAHWs did not use chlorhexidine.

Host risk factors associated with skin outcomes

In unadjusted logistic regression models, a personal history of allergy to any substance was associated with an increased risk of two or more skin symptoms within the preceding 12 months, such as itchy or scratchy skin affecting the hands, or redness affecting the hands (Table 3). It was also associated with probable contact urticaria (OR=3.29, 95% CI 1.37-8.73),

probable contact dermatitis (OR=1.74, 95% CI 1.11-2.75), a past history of WRSS (OR=2.30, 95% CI 1.56-3.39), and WRSS in the past 12 months (definition 1: OR=1.95, 95% CI 1.28-2.99; definition 2: OR=2.20, 95% CI 1.38-3.55) (Table 4). Furthermore, work-related skin outcomes were associated with an increased odds of the HW having a family history of allergy.

Personal domestic cleaning one or more times per week was significantly associated with redness of the skin affecting the hands (OR=7.50, 95% CI 1.61-133.78) and WRSS in the past year (definition 2: OR=3.33, 95% CI 1.34-11.11). Use of chlorine-based cleaning agents at home more than once per week was associated with an increased risk of burning skin of the hands. Use of ammonia-based cleaning agents at home more than once per week was associated with an increased risk of redness and burning affecting the hands, rash within an hour of contact with a rubber latex product, probable contact urticaria, probable contact dermatitis and WRSS.

Occupational risk factors associated with skin outcomes

In multivariate logistic saturated regression models, adjusted for family history of allergy and personal domestic cleaning more than once per week, an approximately four-fold increased risk of probable contact dermatitis and WRSS was found among technicians when compared to administrative clerks (Table 5).

Table 6 outlines the relationships between skin outcomes and the nature of occupational exposures in adjusted models. Hand washing frequency ten or more times per day was associated with two or more skin symptoms in the last 12 months in an unadjusted model (OR_{adj}=2.96, 95% CI: 1.18-9.93) (Supplementary Table 6) but was not significant in these adjusted models.

Workers with probable contact urticaria were more likely to be involved in patients' skin/wound cleaning and disinfection (OR_{adj}=3.10, 95% CI: 1.24-8.81), specimen preparation (OR_{adj}=2.65, 95% CI: 1.06-6.38), use of hydrogen peroxide for medical instrument cleaning and disinfection, formalin 10% for specimen preparation, and SA liquid hand soap (Fresh or Sparkem) for hand washing. Job tasks associated with an increased risk of probable contact urticaria included manual and automatic sterilisation of medical instruments, fixed surface cleaning and disinfection of instruments or equipment, disinfection of patients' skin areas prior to procedures, and use of adhesives or adhesive removing solvents for patients' skin/wound cleaning.

An increased risk of probable contact dermatitis was observed among HWs using Fresh or Sparkem for hand washing, but a protective association was observed for alcohol sanitiser use.

Job tasks associated with an increased risk of probable contact dermatitis included manual and automatic sterilisation of medical instruments, disinfection of patients' skin areas prior to procedures and use of adhesives.

Among the workplace activities, patients' skin/wound cleaning and disinfection significantly increased the risk of WRSS (definition 2: $OR_{adj}=2.70$, 95% CI: 1.64-4.57). An increased risk of WRSS in the past year was seen among those who used chlorhexidine for patients' skin/wound cleaning and disinfection and SA liquid hand soap. All the job tasks involved in patients' skin/wound cleaning and disinfection were associated with an approximately two to three-fold increased risk of WRSS. Manual and automatic sterilisation of medical instruments, and some of the job tasks involved with fixed surfaces cleaning and disinfection were also associated with an increased risk of WRSS in the past 12 months. WRSS in a HW's lifetime were observed with greater odds among those using enzymatic cleaners for medical instrument cleaning and disinfection, dishwashing liquid for fixed surfaces cleaning and disinfection and povidone-iodine for patients' skin or wound cleaning and disinfection.

In contrast to SAHWs, a protective association for probable contact urticaria ($OR_{adj}=0.17$, 95% CI: 0.03-0.64) and WRSS (definition 2: $OR_{adj}=0.34$, 95% CI: 0.16-0.65) was observed for TAHWs using Jet liquid hand soap. Protective associations were also observed for WRSS when using bleach, all-purpose cleaner, or GTA for medical instruments cleaning and disinfection; all-purpose cleaner for fixed surfaces cleaning and disinfection; and among TAHWs when using alcohol sanitiser without chlorhexidine, or all-purpose cleaner for hand washing. Borderline protective associations were found for WRSS when cleaning bathrooms.

Duration and frequency of occupational exposures and skin outcomes

HWs with probable contact urticaria were more likely to be working with chemical agents used for fixed surfaces cleaning and disinfection ($OR_{adj}=4.61$, 95% CI: 1.71-13.66) (Supplementary Table 8) and specimen preparation ($OR_{adj}=4.20$, 95% CI: 1.67-10.18) for a duration of 1-99 minutes per week (Table 7). Similarly, the odds were also increased for performing job tasks that involved medical instruments cleaning and disinfection ($OR_{adj}=2.68$, 95% CI: 1.02-6.99), or patients' skin/wound cleaning and disinfection ($OR_{adj}=6.23$, 95% CI: 2.40-17.30) ≥ 100 minutes per week, and any exposure duration for tasks involving fixed surfaces cleaning and disinfection.

Job tasks of ≥ 100 minutes per week patients' skin/wound cleaning and disinfection were associated with a lifetime and one-year history of WRSS (definition 1). When exposed for 1-

99 minutes per week, the odds ratios suggested a positive association, but the effect was not statistically significant. However, HWs exposed more frequently to chemical agents and job tasks involved in patients' skin cleaning and disinfection had an increased risk of probable contact urticaria and WRSS within the past 12 months. These findings were suggestive of a dose-response relationship.

A higher frequency of chemical agent exposure for specimen preparation was associated with an increased risk of probable contact urticaria (Table 7).

Association between chemical triggers and probable skin disease

HWs with probable contact urticaria were more likely to report latex, OPA, bleach and chlorhexidine as causative agents for their symptoms (Table 8) while those with probable contact dermatitis identified GTA, OPA, ammoniated products, chlorhexidine, bleach and latex as their triggers.

Association between glove usage, training and skin outcomes

As demonstrated in Table 9, the use of gloves when performing manual or automated sterilisation tasks was associated with an increased likelihood of probable contact urticaria, probable contact dermatitis, and WRSS.

Conversely, HWs that received training on the adverse health effects of working with cleaning agents were less likely to report WRSS within the past 12 months (definition 1: $OR_{adj}=0.54$, 95% CI: 0.31-0.89).

Associations in secondary adjusted models

Supplementary tables 9-13 display the findings of the models adjusted additionally for age, gender and atopy, which did not differ meaningfully from the first set of models.

DISCUSSION

This study contributes to a deeper insight into the prevalence and risk factors associated with WRSS in HWs exposed to diverse cleaning agents in an African setting. Importantly, cleaning and disinfection of patients' skin and wounds was a consistent high-risk work activity associated with WRSS. A consistent trend of an increased risk was observed for both chemical agents as well as job tasks related to this activity. Furthermore, a highly suggestive dose-response relationship was observed for WRSS with both duration and frequency of exposure. It is probable that this may be related to the application of highly concentrated solutions of

cleaning agents on localised areas when patients' skin and wounds were disinfected, as opposed to the use of more diluted concentrations of cleaning agent in solutions for large workplace areas, surfaces or equipment.

The one-year prevalence of WRSS in HWs in the current study was only slightly higher than the one-year prevalence of hand dermatitis in the general global population (10-11%)⁸⁻¹⁰, but lower than that reported in other studies of HWs internationally (18.9-66%)⁷. Because HWs surveyed in this study were those still employed in healthcare, an underestimation of effect due to "healthy worker" bias is possible. The absence of an association between duration of employment and WRSS in this study further supports a healthy worker effect. The one-year prevalence of probable contact urticaria was much lower (3.2%), but no other studies of HWs could be identified in the literature for comparative assessment. Furthermore, the most important skin outcomes, including probable contact urticaria, history of WRSS and WRSS in the last 12 months differed significantly between hospitals. It is likely that working in a particular hospital was an effect modifier because the prevalence of these outcomes was significantly different between the two hospitals. This could be explained by the varying policies, work practices, chemical usage and control measures (such as glove usage) between the two hospitals.

In this current study, both a personal and family history of allergy were reported as host-associated risk factors for WRSS. A family history of allergy has been reported as a risk factor for personal allergy³¹, and the latter has previously been identified as a risk factor for WRSS³². Unlike in previous studies^{5-6,33}, atopy and atopic dermatitis were not shown to be significant risk factors for WRSS. Domestic environmental risk factors for WRSS identified in this current study included personal domestic cleaning frequency of more than once per week, especially when using ammonia-based cleaners. It is probable that this observation is based on a dose-response relationship, in that these HWs were more exposed to cleaning agents and cleaning tasks both in the home and at work. Personal domestic cleaning has also been observed in other studies as a risk factor for respiratory symptoms, but similar research assessing the association with WRSS was not evident.^{27,34} While the majority of SAHWs (89.8%) used ammonia-based cleaners frequently, this was not the case for TAHWs, which could be due to different domestic cleaning cultures between the two countries.

Technicians in this current study were identified as an at-risk occupation for WRSS, which is consistent with findings in the study by Kurpiewska et al². Technicians in these hospitals are usually exposed to frequent handwashing, soaps, and disinfectants for medical instruments.²

Apart from cleaning-related causes, some are also exposed to nickel in metal instruments, epoxies and resins.² In contrast to some other studies^{2,11,13-14}, work in a nursing or cleaner role was not found to be a significant risk factor.

In this study, glove usage during manual and automatic sterilisation tasks were risk factors for WRSS as well as probable contact urticaria or contact dermatitis. The associations between these job tasks (with gloves) and adverse skin outcomes were generally stronger than for job task alone. Prolonged and/or frequent use of waterproof gloves may be considered as wet work, due to sweaty hands, frequent wet-dry cycles, and water or other chemical solutions that could run down the arms into the gloves as has also been observed in other studies.^{15,16} Various studies have shown that wet work is an independent risk factor for irritant contact dermatitis.^{15,16} Apart from wet work, latex gloves were also self-identified by HWs as significant work-related triggers for these skin outcomes. Specific information on the constituents of gloves used was not provided by the suppliers to explore this further, but it is probable that supposedly low protein latex gloves may have much higher allergen concentrations than reported by suppliers.^{18,19} Although preventive measures for latex allergy have been implemented in the hospitals, it is also probable that some HWs were sensitised to latex protein in the past. Furthermore, other constituent chemicals present in these gloves may be another contributory factor to WRSS.

The activity of specimen preparation and the use of 10% formalin was consistently associated with the probable contact urticaria in this study. In addition, a dose-response relationship was evident between the specimen preparation activity and chemical agents involved, and this skin disease phenotype. Although better known as a causative agent for ACD³⁵, formalin as a cause for contact urticaria has been suggested by some published case series and case reports.³⁶⁻³⁹ Symptoms occur following occupational exposure (usually via the skin) and are sometimes systemic; hence, it is believed to be immunologic/allergic in nature.³⁶ Further epidemiological and laboratory evidence is necessary to better explore this association.

In this current study, occupational determinants associated with probable contact dermatitis affecting the hands were observed with manual and automatic sterilisation of instruments, and the disinfection of patients' skin or wounds. Stronger associations were observed for automatic sterilisation compared to manual sterilisation. A Japanese study measured environmental OPA levels and found higher concentrations in rooms where manual sterilisation was performed compared to automatic.⁴⁰ However, HWs that performed automatic sterilisation with OPA in this current study also performed manual sterilisation tasks, probably explaining these stronger

associations between automatic sterilisation tasks and probable contact dermatitis.⁴¹ Biomonitoring would better approximate HWs' OPA exposure to further assess the dose-response relationships, but this was not possible. Moreover, pre-cleaning agents may vary between these tasks and could also be implicated in causing contact dermatitis.

HWs self-identified OPA and chlorhexidine as important work-related triggers for probable contact urticaria and contact dermatitis in this study. OPA was used for disinfection of instruments in the SA hospital (compared to GTA in the Tanzanian hospital) and is known to cause both irritant and IgE-mediated allergic reactions – more so than GTA despite the presumption that OPA was considered to be safer.⁴² Furthermore, concomitant irritant and allergic reactions, including reports of occupational asthma and anaphylaxis, have been attributed to OPA in previous studies.⁴³⁻⁴⁷ Chlorhexidine, which was also found to be a risk factor for WRSS, when cleaning or disinfecting patients' skin/wounds, has similarly been reported as an occupational allergen for both immediate and delayed hypersensitivity reactions^{13,14} as well as implicated in anaphylactic reactions⁴⁸.

In this current study, HWs also self-identified chlorine-based and ammonia-based cleaners as important work-related triggers for probable contact urticaria and contact dermatitis, but no dose-response associations were evident. However, domestic use of ammoniated cleaners more than once per week, was identified as a risk factor for WRSS. Apparent protective associations found between WRSS and the use of bleach for medical instruments cleaning and disinfection at work, were not observed for other tasks involving bleach. Interestingly, use of household bleach has been associated with less atopic sensitisation by Zock et al⁴⁹ but increased the risk of respiratory symptoms. It is possible that there could be a task-specific effect modifier such as the concentration of bleach used or specific PPE worn that varied between work activities, that was not considered. However, the underlying biological mechanism for this association remains unclear and future studies need to explore this further.

The protective role of training observed in this study has also been observed in other studies. Rahman et al⁵⁰ observed that knowledge of occupational hazards lowered the prevalence of OCD in chemical industry workers and Mekonnen et al¹² observed that a lack health and safety training among HWs was associated with an increased risk of OCD ($OR_{adj}=2.12$, 95% CI: 1.12-2.25). This preventive measure is generally easily implementable in the workplace as part of the occupational health and safety training programme and has the potential to modify occupational risks.

To the researcher's knowledge, this is the first study that explored detailed information on potential occupational risk factors in the African setting. A strength of the study is that it obtained detailed information on the duration and frequency of various chemical and job task exposures in order to assess dose-response relationships. However, it could be argued that the exposure metrics that were used could have been further refined to better approximate exposures in the absence of more objective exposure measurements.

Since this was a cross-sectional study, a major limitation of this study design is that time-dependent data was not available to better assess temporal associations. It is noted that with multiple comparisons, some findings may be due to chance. However, the analysis of these associations was decided a-priori. It is also probable that some of the "protective associations" observed may have been due to a healthy worker effect. The study relied on self-reported information via the interviewer-led questionnaire and there was a potential for information bias, especially in the identification of suspected chemical agent triggers for their symptoms. No physical examination of the participants' skin was performed, nor was any patch testing conducted, precluding the ability to have more accurate diagnostic information of those HWs with WRSS. It is acknowledged that further objective measures of exposure, such as quantitative exposure assessments where appropriate, and objective measurements of dermatitis (for example, trans-epidermal water loss [TEWL]) would have strengthened the study. Furthermore, more detailed information on glove usage could have provided better insights into the glove use practices and their impact on the adverse skin outcomes. Additionally, information could have been collected on other preventive measures such as medical surveillance and safe procurement practices, which could have modified the effects observed.

In conclusion, this study has demonstrated that HWs exposed to various cleaning agents in tertiary hospitals are at an increased risk of WRSS when compared to the general population. Significant risks were demonstrated for chemical exposures associated with cleaning and disinfection of patients' skin and wounds as well as specimen preparation. The importance of preventive measures such as training and the use of alcohol-based sanitisers to disinfect hands has been highlighted. Further research into dose-response relationships using more objective exposure metrics and adverse skin outcomes could provide more specificity to the associations observed. In addition, research on the underlying mechanisms for these associations could contribute towards improved insights on early detection of work-related skin disease in HWs.

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TABLES

Table 1: Host-related and occupational characteristics of health workers employed in the two tertiary hospitals

	SAHWs	TAHWs	Total	P-value (Chi-squared test)
	n = 344 (%)	n = 353 (%)	N = 697 (%)	
Host-related characteristics				
Demographic				
Age (years)	46 (33-51)	39 (31-51)	42 (32-51)	0.010*
Gender				
- Female	288 (83.7)	249 (70.5)	537 (77.0)	<0.001
- Male	56 (16.3)	104 (29.5)	160 (23.0)	
Medical history				
Family history of allergy	219 (63.7)	134 (38.0)	353 (50.6)	<0.001
Atopy (Phadiatop positive)	160 (46.5)	136 (38.5)	296 (42.5)	0.048
History of allergy to any agent (including insect bites or stings, foods, medication, or latex)	97 (28.2)	167 (47.3)	264 (37.9)	<0.001
History of atopic dermatitis	18 (5.2)	4 (1.1)	22 (3.2)	0.004
Domestic chemical exposures				
Frequency of personally cleaning home (≥ 1 day/week)	327 (95.1)	274 (77.6)	601 (86.2)	<0.001
Cleaning products used:				
- Chlorine based (≥ 1 day/week)	270 (78.5)	82 (23.2)	352 (50.5)	<0.001
- Ammonia based (≥ 1 day/week)	309 (89.8)	0 (0.0)	309 (44.3)	<0.001
- Window cleaners (≥ 1 day/week)	43 (12.5)	0 (0.0)	43 (6.2)	<0.001
Occupational characteristics				
Department				
Operating Theatres	91 (26.4)	117 (33.1)	208 (29.8)	<0.001
Intensive Care Unit (ICU)	107 (31.1)	65 (18.4)	172 (24.8)	
Emergency Unit:	36 (10.5)	78 (22.1)	114 (16.4)	
- Emergency	12 (3.5)	78 (22.1)	90 (12.9)	
- Trauma	20 (5.8)	-	-	
- Gynae emergency	4 (1.2)	-	-	
Outpatients Department (OPD):	54 (15.7)	43 (12.2)	97 (13.9)	
- General	-	25 (7.1)	-	
- Gastrointestinal tract (GIT) and endoscopy	8 (2.3)	11 (3.1)	19 (2.7)	
- Cardiac	12 (3.5)	-	-	
- Respiratory	12 (3.5)	-	-	
- Oral and maxillofacial	3 (0.9)	9 (2.6)	12 (1.7)	
- ENT	3 (0.9)	4 (1.1)	7 (1.0)	
- Surgery	4 (1.2)	3 (0.9)	7 (1.0)	
- Urology	6 (1.7)	-	-	
- Eye	4 (1.2)	-	-	
- Gynae colposcopy	2 (0.6)	2 (0.6)	4 (0.6)	
Haemodialysis unit	18 (5.2)	17 (4.8)	35 (5.0)	
Vascular radiology	25 (7.3)	-	-	
Central Sterile Services Department (CSSD)	-	22 (6.2)	-	

Section C: Journal Manuscript

Ear, Nose and Throat (ENT) ward	13 (3.8)	-	-	
Job title				
Nursing:	239 (69.5)	287 (81.3)	526 (75.5)	<0.001
- <i>Registered professional nurse</i>	132 (38.4)	151 (42.8)	283 (40.6)	
- <i>Nurse assistant / health attendant</i>	59 (17.2)	109 (30.9)	168 (24.1)	
- <i>Enrolled nurse</i>	48 (14.0)	27 (7.7)	75 (10.8)	
Cleaner	45 (13.1)	40 (11.3)	85 (12.2)	
Clerk/Administrative	13 (3.8)	25 (7.1)	38 (5.5)	
Technician	33 (9.6)	1 (0.3)	34 (4.9)	
Porter	14 (4.1)	-	-	
Employment history				
Duration in health care (years)	20 (8-28)	11 (4-27)	14 (6-28)	<0.001*
Duration in current department (years)	4 (1-11)	4 (2-8)	4 (2-9)	0.862*
Previous health work in other departments in current hospital (yes vs no)	337 (98.0)	195 (55.2)	532 (76.3)	<0.001

SAHWs – South African health workers, TAHWs – Tanzanian health workers

Reported in median (interquartile range) or frequency: n (%) as appropriate for the type of data.

*Wilcoxon rank sum test

Table 2: Prevalence of skin symptoms among health workers in the two tertiary hospitals

	SAHWs n (%)	TAHWs n (%)	Total N (%)	P-value (Chi- squared test)
Two or more skin symptoms in the last 12 months	82 (23.8)	43 (12.3)	125 (17.9)	<0.001
- Itchy/scratchy skin affecting hands	40 (11.6)	32 (9.1)	72 (10.3)	0.324
- Redness of the skin affecting hands	34 (9.8)	11 (3.1)	45 (6.5)	0.567
- Burning skin affecting hands	22 (6.4)	2 (0.6)	24 (3.4)	<0.001
- Hives (“bommels”) affecting hands	9 (2.6)	6 (1.7)	15 (2.2)	0.720
- Blisters or weeping skin affecting hands	6 (1.7)	4 (1.1)	10 (1.4)	<0.001
- Rash within an hour of contact with a rubber latex product affecting hands	7 (2.0)	1 (0.3)	8 (1.2)	0.070
- Dry, scaly skin affecting hands	0 (0.0)	7 (2.0)	7 (1.0)	0.025
Probable contact dermatitis**	50 (14.5)	36 (10.2)	86 (12.3)	0.104
Probable contact urticaria*	16 (4.7)	6 (1.7)	22 (3.2)	0.044
Lifetime history of WRSS (WRSS ever)	95 (27.6)	35 (9.9)	130 (18.7)	<0.001
WRSS in the last 12 months (Definition 1)	76 (22.1)	27 (7.7)	103 (14.8)	<0.001
WRSS in the last 12 months (Definition 2)	61 (17.7)	19 (5.4)	80 (11.5)	<0.001
Doctor diagnosed work-related skin disease	16 (4.7)	4 (1.1)	20 (2.9)	0.628
Self-identification of chemicals causing WRSS				
- Chlorhexidine	54 (15.7)	-	-	<0.001
- Latex	12 (3.5)	7 (2.0)	19 (2.7)	0.323
- Bleach / chlorine-based products	11 (3.2)	6 (1.7)	17 (2.4)	0.300
- Liquid soap	10 (2.9)	1 (0.3)	11 (1.6)	0.013
- Ortho-phthalaldehyde (OPA)	5 (1.5)	2 (0.6)	7 (1.0)	0.427
- Glutaraldehyde (GTA)	2 (0.6)	3 (0.9)	5 (0.7)	1.000
- Quarternary ammonium compounds (QACs)	4 (1.2)	-	-	0.509
- Enzymatic cleaners	2 (0.6)	1 (0.3)	3 (0.4)	0.982
- Ammoniated products	2 (0.6)	1 (0.3)	3 (0.4)	0.982
- All-purpose cleaner	-	4 (1.1)	-	0.140
- Other (e.g., other instrument and surface cleaners, floor cleaners, adhesives, dust, gases and vapours)	84 (24.4)	35 (9.9)	119 (17.1)	<0.001

SAHWs – South African health workers, TAHWs – Tanzanian health workers, WRSS – work-related skin symptoms

Table 3: Association between host-related factors and general skin outcomes in unadjusted logistic regression models

Unadjusted odds ratio (95% Confidence Interval)								
	Two or more skin symptoms in the last 12 months	Itchy/scratchy skin affecting the hands	Hives (“bommels”) affecting the hands	Dry/scaly skin affecting the hands	Redness of the skin affecting the hands	Blisters or weeping skin affecting the hands	Burning skin affecting the hands	Rash within an hour of contact with a rubber latex product
Age	1.01 (0.99 – 1.03)	1.00 (0.98 – 1.02)	0.99 (0.94 – 1.03)	0.99 (0.93 – 1.06)	1.02 (0.99 – 1.05)	1.02 (0.97 – 1.09)	1.01 (0.98 – 1.05)	1.02 (0.96 – 1.09)
Gender: Females (vs Males)	1.10 (0.70 – 1.78)	1.55 (0.84 – 3.10)	0.82 (0.27 – 2.98)	0.39 (0.09 – 2.01)	1.66 (0.77 – 4.14)	2.71 (0.50 – 50.17)	3.37 (0.98 – 21.21)	2.10 (0.37 – 39.41)
Family history of allergy	1.07 (0.73 – 1.58)	1.17 (0.72 – 1.92)	0.64 (0.21 – 1.80)	0.39 (0.06 – 1.81)	1.07 (0.73 – 1.58)	3.97 (0.99 – 26.40)	1.38 (0.61 – 3.24)	0.97 (0.23 – 4.15)
Atopy	1.00 (0.67 – 1.47)	1.09 (0.67 – 1.78)	1.19 (0.41 – 3.35)	1.82 (0.40 – 9.28)	0.90 (0.48 – 1.65)	0.90 (0.23 – 3.19)	0.81 (0.33 – 1.84)	2.28 (0.55 – 11.18)
History of allergy to any agent	1.65 (1.12 – 2.44)*	1.76 (1.08 – 2.88)*	2.26 (0.81 – 6.81)	3.75 (0.80 – 26.31)	1.93 (1.05 – 3.59)*	2.25 (0.64 – 8.86)	1.26 (0.55 – 2.87)	NC
History of atopic dermatitis	1.02 (0.29 – 2.78)	0.86 (0.14 – 3.05)	2.25 (0.12 – 12.02)	NC	1.47 (0.23 – 5.26)	NC	1.35 (0.07 – 6.91)	NC
Personal domestic cleaning frequency (\geq 1 time / week)	1.46 (0.81 – 2.83)	0.99 (0.51 – 2.12)	1.04 (0.28 – 6.71)	0.39 (0.08 – 2.78)	7.50 (1.61 – 133.78)*	0.23 (0.07 – 0.92)	3.78 (0.78 – 68.03)	1.12 (0.20 – 21.05)
Domestic cleaning agent exposure (\geq 1 time / week):								
- Chlorine based	1.26 (0.85 – 1.86)	0.86 (0.53 – 1.41)	0.85 (0.30 – 2.41)	NC	1.24 (0.68 – 2.30)	0.65 (0.16 – 2.29)	3.04 (1.26 – 8.48)*	7.02 (0.86 – 57.36)
- Ammonia based	2.17 (1.46 – 3.23)**	1.55 (0.95 – 2.55)	1.45 (0.51 – 4.17)	NC	3.33 (1.76 – 6.69)**	1.90 (0.54 – 7.49)	9.36 (3.19 – 39.89)**	8.97 (1.58 – 168.13)*
- Window cleaners	1.05 (0.44 – 2.21)	0.88 (0.26 – 2.28)	2.41 (0.37 – 9.10)	NC	1.53 (0.44 – 4.05)	NC	1.40 (0.22 – 4.98)	2.20 (0.12 – 12.78)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; *: P -value < 0.05; **: P -value < 0.01

NC: not calculable

Each OR represents a separate unadjusted regression model

Table 4: Association between host-related factors and work-related skin outcomes in unadjusted logistic regression models

Unadjusted odds ratio (95% Confidence Interval)					
	Probable contact urticaria	Probable contact dermatitis	WRSS ever	WRSS in the last 12 months (Definition 1)	WRSS in the last 12 months (Definition 2)
Age	1.00 (0.96 – 1.04)	1.01 (0.99 – 1.03)	1.01 (0.99 – 1.03)	1.01 (0.99 – 1.03)	1.01 (0.99 – 1.03)
Gender: Females (vs Males)	1.35 (0.50 – 4.73)	1.35 (0.78 – 2.47)	1.58 (0.98 – 2.65)	1.48 (0.88 – 2.62)	1.61 (0.89 – 3.13)
Family history of allergy	0.81 (0.34 – 1.89)	1.14 (0.72 – 1.80)	1.66 (1.13 – 2.45)*	1.65 (1.08 – 2.55)*	1.83 (1.14 – 3.00)*
Atopy	1.13 (0.47 – 2.66)	1.08 (0.68 – 1.70)	1.03 (0.70 – 1.51)	0.88 (0.57 – 1.34)	0.84 (0.52 – 1.35)
History of allergy to any agent	3.29 (1.37 – 8.73)*	1.74 (1.11 – 2.75)*	2.30 (1.56 – 3.39)**	1.95 (1.28 – 2.99)**	2.20 (1.38 – 3.55)**
History of atopic dermatitis	1.48 (0.08 – 7.64)	0.70 (0.11 – 2.47)	1.67 (0.59 -4.14)	1.73 (0.56 – 4.49)	2.35 (0.76 – 6.15)
Personal domestic cleaning frequency (≥ 1 time / week)	1.62 (0.46 – 10.24)	1.10 (0.58 – 2.27)	3.27 (1.58 – 7.94)**	3.55 (1.55 – 10.26)*	3.33 (1.34 – 11.11)*
Domestic cleaning agent exposure (≥ 1 time / week):					
- Chlorine based	1.74 (0.74 – 4.42)	0.98 (0.62 – 1.54)	1.43 (0.97 – 2.10)	1.32 (0.86 – 2.01)	1.46 (0.91 – 2.35)
- Ammonia based	2.78 (1.16 – 7.35)*	1.69 (1.08 – 2.68)*	2.89 (1.95 – 4.34)**	2.99 (1.94 – 4.70)**	3.36 (2.05 – 5.65)**
- Window cleaners	2.51 (0.57 – 7.75)	0.93 (0.31 – 2.23)	1.35 (0.62 – 2.72)	1.13 (0.45 – 2.47)	1.27 (0.47 – 2.91)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; *: P -value < 0.05 ; **: P -value < 0.01

WRSS: Work-related skin symptoms

Each OR represents a separate unadjusted regression model

Table 5: Association between occupational factors and work-related skin outcomes in adjusted logistic regression models

Adjusted odds ratio (95% Confidence Interval)					
<i>Job title</i>	Probable contact urticaria (n=22)	Probable contact dermatitis (n=86)	WRSS ever (n=130)	WRSS in the last 12 months (Definition 1) (n=103)	WRSS in the last 12 months (Definition 2) (n=80)
- Clerk/Administrative	Reference	Reference	Reference	Reference	Reference
- Nursing (n=526)	0.52 (0.14-3.36)	1.18 (0.45-4.06)	1.92 (0.73-6.59)	1.44 (0.55-4.96)	1.51 (0.51-6.44)
Registered professional nurse (n=283)	0.53 (0.13-3.63)	1.32 (0.49-4.61)	2.31 (0.86-8.02)	1.83 (0.68-6.38)	1.80 (0.60-7.78)
Nursing assistant (n=168)	0.29 (0.05-2.28)	0.83 (0.28-3.07)	1.33 (0.46-4.81)	0.98 (0.33-3.62)	1.21 (0.37-5.46)
Enrolled nurse (n=75)	0.97 (0.18-7.27)	1.46 (0.46-5.60)	1.83 (0.59-6.91)	1.07 (0.32-4.23)	1.12 (0.29-5.49)
- Cleaner (n=85)	0.19 (0.01-2.06)	0.76 (0.21-3.09)	1.58 (0.51-5.97)	0.94 (0.28-3.69)	0.84 (0.21-4.21)
- Technician (n=34)	1.76 (0.27-14.31)	4.08 (1.22-16.35)*	4.79 (1.47-18.98)*	3.70 (1.11-14.75)*	4.45 (1.21-21.48)*
- Porter (n=14)	NC	NC	0.68 (0.03-5.25)	0.68 (0.03-5.25)	NC
<i>Employment history</i>					
- Duration in health work	1.00 (0.97-1.04)	1.01 (0.99-1.03)	1.01 (1.00-1.03)	1.01 (0.99-1.03)	1.01 (0.99-1.03)
- Duration in current department	1.02 (0.96-1.07)	1.02 (0.99-1.05)	1.03 (1.00-1.05)	1.02 (0.99-1.05)	1.02 (0.99-1.05)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; *: P -value < 0.05; **: P -value < 0.01

NC: not calculable; WRSS: work-related skin symptoms

Each OR represents a separate regression model adjusted for host-related factors (family history of allergy to any substance and personal domestic cleaning frequency ≥ 1 time / week).

Table 6: Association between nature of occupational exposures and work-related skin outcomes in adjusted logistic regression models

Adjusted odds ratio (95% Confidence Interval)					
	Probable contact urticaria (n=22)	Probable contact dermatitis (n=86)	WRSS ever (n=130)	WRSS in the last 12 months (Definition 1) (n=103)	WRSS in the last 12 months (Definition 2) (n=80)
Wet work:					
- Handwash frequency \geq 10 times/day (n=642)	NC	1.87 (0.73-6.31)	1.51 (0.70-3.76)	1.34 (0.59-3.60)	1.23 (0.51-3.67)
Workplace activity:					
- Hand washing / sanitising (n=697)	NC	NC	NC	NC	NC
- Fixed surfaces cleaning and disinfection (n=572)	2.19 (0.62-13.94)	1.12 (0.62-2.14)	1.61 (0.92-2.98)	1.39 (0.77-2.71)	2.14 (0.95-4.80)
- Patients' skin / wound cleaning and disinfection (n=327)	3.10 (1.24-8.81)*	1.58 (1.00-2.52)	2.40 (1.61-3.63)**	2.80 (1.79-4.48)**	2.70 (1.64-4.57)**
- Medical instruments cleaning and disinfection (n=301)	1.71 (0.72-4.14)	0.93 (0.58-1.47)	1.00 (0.67-1.47)	0.77 (0.49-1.18)	0.75 (0.46-1.21)
- Specimen preparation (n=157)	2.65 (1.06-6.38)*	1.02 (0.58-1.73)	1.10 (0.69-1.71)	0.95 (0.56-1.55)	0.67 (0.36-1.20)
Cleaning agent use (by workplace activity):					
Medical instruments cleaning and disinfection					
- Enzymatic cleaners (n=113)	2.08 (0.73-5.26)	1.09 (0.58-1.94)	1.77 (1.09-2.82)*	1.04 (0.58-1.79)	0.73 (0.35-1.40)
- Ortho-phthalaldehyde (n=113)	2.66 (0.98-6.54)	1.42 (0.79-2.46)	1.49 (0.90-2.40)	1.23 (0.70-2.09)	0.93 (0.47-1.71)
- Chlorhexidine (n=84)	1.69 (0.47-4.82)	1.18 (0.58-2.22)	1.50 (0.87-2.53)	1.42 (0.78-2.49)	1.68 (0.88-3.04)
- Hydrogen peroxide (n=40)	4.27 (1.18-12.37)*	1.86 (0.77-4.01)	1.34 (0.58-2.84)	1.29 (0.51-2.90)	1.13 (0.38-2.79)
- Bleach (n=204)	0.94 (0.33-2.36)	0.71 (0.40-1.19)	0.48 (0.28-0.77)**	0.34 (0.17-0.60)**	0.39 (0.19-0.72)*
- All-purpose cleaner (n=132)	0.43 (0.07-1.53)	0.67 (0.33-1.26)	0.29 (0.12-0.57)**	0.13 (0.03-0.36)**	0.12 (0.02-0.38)**
- Glutaraldehyde (n=49)	0.64 (0.04-3.18)	0.62 (0.18-1.57)	0.62 (0.23-1.40)	0.12 (0.01-0.54)*	0.16 (0.02-1.15)
Fixed surfaces cleaning and disinfection					
- Bleach (n=474)	0.66 (0.28-1.62)	0.91 (0.57-1.48)	1.24 (0.81-1.91)	1.12 (0.71-1.81)	1.53 (0.90-2.71)
- Ammonia (n=73)	0.83 (0.13-2.96)	1.61 (0.81-3.01)	1.28 (0.70-2.25)	1.35 (0.71-2.45)	1.22 (0.58-2.36)
- Dishwashing liquid (n=138)	2.36 (0.91-5.77)	1.35 (0.77-2.28)	1.59 (1.01-2.47)*	1.51 (0.92-2.43)	1.41 (0.81-2.39)
- All-purpose cleaner (n=202)	0.37 (0.09-1.13)	0.73 (0.41-1.23)	0.42 (0.24-0.69)**	0.36 (0.19-0.64)*	0.42 (0.20-0.79)*
- Enzymatic cleaners (n=42)	1.61 (0.25-5.80)	1.74 (0.73-3.73)	1.91 (0.91-3.81)	1.44 (0.60-3.10)	1.36 (0.50-3.15)
Specimen preparation					
- Formalin 10% solution (n=148)	2.84 (1.14-6.83)*	1.04 (0.58-1.77)	1.04 (0.64-1.64)	0.91 (0.53-1.52)	0.67 (0.35-1.22)

Patients' skin / wound cleaning and disinfection					
- Chlorhexidine (n=65)	3.10 (0.98-8.41)	1.67 (0.81-3.21)	1.63 (0.89-2.87)	1.89 (1.01-3.42)*	2.19 (1.12-4.08)*
- Povidone iodine (n=49)	3.03 (0.84-8.64)	1.18 (0.47-2.58)	2.02 (1.04-3.77)*	1.76 (0.84-3.43)	1.62 (0.71-3.36)
Hand washing / sanitising					
- Chlorhexidine (n=337)	NC	NC	0.50 (0.11-2.60)	0.72 (0.15-5.12)	0.54 (0.11-3.86)
- Liquid hand soap (n=305)	3.10 (1.23-8.69)*	1.67 (1.03-2.72)*	2.62 (1.73-4.01)**	2.58 (1.64-4.13)**	2.50 (1.51-4.24)**
- Alcohol sanitiser (n=79)	0.37 (0.02-1.83)	0.26 (0.06-0.71)*	0.30 (0.10-0.69)*	0.15 (0.02-0.49)*	0.20 (0.03-0.67)*
- All-purpose cleaner (diluted) (n=153)	0.74 (0.21-2.08)	1.14 (0.64-1.95)	0.50 (0.27-0.86)*	0.71 (0.38-1.24)	0.42 (0.18-0.86)*
- Hand wash liquid soap (n=235)	0.17 (0.03-0.64)*	0.63 (0.35-1.07)	0.36 (0.21-0.60)**	0.26 (0.13-0.49)**	0.34 (0.16-0.65)**
<i>Job task (by workplace activity):</i>					
Medical instruments cleaning and disinfection					
- Manually disassemble instruments or remove gross contaminants (n=202)	1.44 (0.56-3.45)	1.19 (0.72-1.93)	1.28 (0.84-1.92)	1.21 (0.77-1.90)	1.17 (0.70-1.92)
- Prepare cleaning solutions (diluting or mixing) (n=251)	1.01 (0.39-2.40)	0.93 (0.57-1.49)	1.23 (0.82-1.81)	0.95 (0.61-1.47)	1.10 (0.68-1.78)
- Change sterilizing solutions (n=157)	0.76 (0.22-2.08)	0.68 (0.37-1.20)	0.95 (0.60-1.50)	0.68 (0.39-1.15)	0.58 (0.29-1.05)
- Manually sterilise or high-level disinfect (n=143)	3.55 (1.44-8.60)**	1.94 (1.15-3.19)*	1.93 (1.24-2.96)**	1.70 (1.05-2.72)*	1.53 (0.89-2.58)
- Sterilise instruments with automated systems (n=16)	8.67 (1.84-30.92)**	3.28 (1.01-9.32)*	3.94 (1.40-11.12)*	5.34 (1.89-15.17)**	3.05 (0.92-8.80)
Fixed surfaces cleaning and disinfection					
- Use more wipes vs more sprays (n=452)	1.17 (0.49-3.11)	1.08 (0.68-1.77)	0.69 (0.47-1.03)	0.65 (0.43-1.01)	0.66 (0.41-1.07)
- Manually mix, refill, or empty cleaning/disinfecting products (n=353)	0.78 (0.32-1.86)	1.11 (0.70-1.78)	1.54 (1.04-2.31)*	1.41 (0.91-2.20)	1.56 (0.96-2.58)
- Clean instruments or equipment (n=403)	3.36 (1.23-11.76)*	1.25 (0.79-2.02)	1.61 (1.07-2.45)*	1.89 (1.20-3.05)*	2.21 (1.32-3.86)**
- Terminal cleaning of patient rooms (n=155)	0.99 (0.32-2.58)	0.97 (0.54-1.65)	1.18 (0.75-1.83)	1.33 (0.82-2.12)	1.69 (1.00-2.80)*
- Clean up blood and spills (n=377)	0.84 (0.35-2.01)	1.40 (0.88-2.26)	1.54 (1.04-2.32)*	1.32 (0.86-2.06)	1.49 (0.92-2.46)
- Clean bathrooms (n=104)	0.26 (0.01-1.26)	1.01 (0.54-1.91)	0.64 (0.34-1.14)	0.58 (0.29-1.16)	0.43 (0.18-1.03)
Patients' skin / wound cleaning and disinfection					
- Disinfect skin areas on patients prior to procedure (n=251)	3.21 (1.34-8.24)*	2.29 (1.45-3.66)**	2.01 (1.36-2.98)**	2.55 (1.66-3.95)**	2.33 (1.44-3.77)**

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- Clean and disinfect wounds (n=161)	1.56 (0.59-3.79)	1.16 (0.67-1.92)	1.48 (0.96-2.27)	1.63 (1.02-2.57)*	2.12 (1.28-3.46)**
- Apply wound dressing (n=143)	1.85 (0.69-4.49)	1.48 (0.86-2.45)	1.87 (1.20-2.87)**	2.04 (1.27-3.24)**	2.66 (1.60-4.36)**
- Use adhesives (n=277)	3.44 (1.39-9.37)*	1.91 (1.20-3.07)*	2.66 (1.79-3.99)**	3.35 (2.15-5.31)**	3.48 (2.11-5.88)**
- Use adhesive removing solvents (n=196)	2.78 (1.14-6.87)*	1.41 (0.86-2.31)	1.96 (1.30-2.94)**	2.24 (1.44-3.48)**	3.02 (1.85-4.93)**

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; *: P -value < 0.05; **: P -value < 0.01

NC: not calculable; WRSS: work-related skin symptoms

Each OR represents a separate regression model adjusted for host-related factors (family history of allergy to any substance and personal domestic cleaning frequency ≥ 1 time / week). Reference group of comparison are those workers who reported that they were not using the chemical or were not performing the task.

Table 7: Association between duration and frequency of occupational exposures and work-related skin outcomes in adjusted logistic regression models

	Adjusted odds ratio (95% Confidence Interval)				
	Probable contact urticaria (n=22)	Probable contact dermatitis (n=86)	WRSS ever (n=130)	WRSS in the last 12 months (Definition 1) (n=103)	WRSS in the last 12 months (Definition 2) (n=80)
<i>Duration of chemical agent exposure by work activity</i>					
Specimen preparation					
1-99 mins/week	4.20 (1.67-10.18)**	1.34 (0.73-2.34)	1.19 (0.70-1.95)	1.08 (0.60-1.87)	0.84 (0.42-1.58)
≥ 100 mins/week	NC	NC	1.23 (0.06-8.92)	1.61 (0.08-11.82)	NC
Patients' skin / wound cleaning and disinfection					
1-99 mins/week	2.83 (0.78-8.13)	1.48 (0.65-3.05)	1.14 (0.55-2.18)	1.39 (0.65-2.73)	1.92 (0.89-3.82)
≥ 100 mins/week	1.93 (0.10-10.73)	1.70 (0.48-4.83)	2.27 (0.87-5.61)	2.52 (0.92-6.35)	2.11 (0.66-5.70)
<i>Duration of job task exposure by work activity</i>					
Patients' skin / wound cleaning and disinfection					
1-99 mins/week	2.46 (0.63-8.33)	0.95 (0.47-1.80)	1.63 (0.97-2.69)	1.61 (0.90-2.78)	1.44 (0.76-2.63)
≥ 100 mins/week	6.23 (2.40-17.30)**	1.71 (0.98-2.91)	1.80 (1.10-2.90)*	2.05 (1.21-3.42)*	1.67 (0.91-2.95)
<i>Frequency of chemical exposure by work activity</i>					
Specimen preparation (days/week)	1.28 (1.04-1.53)*	1.03 (0.87-1.19)	1.06 (0.92-1.20)	1.05 (0.89-1.20)	0.94 (0.76-1.12)
Patients' skin / wound cleaning and disinfection (days/week)	1.36 (1.10-1.64)**	1.10 (0.95-1.26)	1.13 (1.00-1.27)*	1.16 (1.02-1.31)*	1.17 (1.02-1.33)*
<i>Frequency of job task exposure by work activity</i>					
Patients' skin / wound cleaning and disinfection					
- Days/week	1.38 (1.13-1.68)**	1.09 (0.97-1.21)	1.12 (1.02-1.23)**	1.15 (1.03-1.27)**	1.11 (0.99-1.24)
- Times/day	1.11 (1.04-1.19)**	1.03 (0.97-1.08)	1.03 (0.98-1.08)	1.04 (0.99-1.09)	1.02 (0.96-1.08)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; *: P -value < 0.05; **: P -value < 0.01

NC: not calculable; WRSS: work-related skin symptoms

Each OR represents a separate regression model adjusted for host-related factors (family history of allergy to any substance and personal domestic cleaning frequency ≥ 1 time / week). Reference group of comparison were those workers who reported that they were not using the chemical or were not performing the task.

Table 8: Association between self-identification of chemicals causing work-related skin outcomes in adjusted logistic regression models

Adjusted odds ratio (95% Confidence Interval)		
<i>Chemical type</i>	Probable contact urticaria (n=22)	Probable contact dermatitis (n=86)
Ortho-phthalaldehyde (n=7)	15.95 (2.13-84.48)**	19.03 (4.00-135.28)**
Glutaraldehyde (n=5)	8.13 (0.40-58.76)	30.66 (4.45-605.21)**
Enzymatic cleaners (n=3)	15.93 (0.72-175.50)	NC
Chlorhexidine (n=54)	5.09 (1.72-13.58)**	7.82 (4.21-14.49)**
Quarternary ammonium compounds (n=4)	12.09 (0.58-103.94)	7.16 (0.85-60.6)
Bleach / chlorine-based products (n=17)	7.42 (1.61-25.43)**	6.78 (2.48-18.29)**
Ammoniated products (n=3)	NC	14.80 (1.40-321.57)*
Latex (n=19)	18.60 (5.90-54.3)**	5.61(2.11-14.33)**
Liquid soap (n=11)	NC	2.58 (0.55-9.35)
All-purpose cleaner (n=4)	NC	2.54 (0.12-20.45)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; *: *P*-value < 0.05; **: *P*-value < 0.01

NC: not calculable

Each OR represents a separate regression model adjusted for host-related factors (family history of allergy to any substance and personal domestic cleaning frequency ≥ 1 time / week). Reference group of comparison was those workers who did not identify the chemical as a cause of work-related skin outcomes.

Table 9: Association between glove usage or training at work and skin outcomes in adjusted logistic regression models

Adjusted odds ratio (95% Confidence Interval)					
	Probable contact urticaria (n=22)	Probable contact dermatitis (n=86)	WRSS ever (n=130)	WRSS in the last 12 months (Definition 1) (n=103)	WRSS in the last 12 months (Definition 2) (n=80)
Glove usage for medical instruments cleaning and disinfection (n=321)	1.45 (0.61-3.5)	1.01 (0.64-1.59)	1.26 (0.85-1.85)	1.08 (0.70-1.65)	1.15 (0.72-1.85)
- Manually disassemble instruments or remove gross contaminants (n=195)	1.51 (0.59-3.62)	1.11 (0.67-1.81)	1.24 (0.81-1.87)	1.15 (0.72-1.81)	1.16 (0.69-1.91)
- Prepare cleaning solutions (diluting or mixing) (n=232)	0.92 (0.35-2.22)	0.89 (0.54-1.44)	1.13 (0.75-1.68)	0.81 (0.51-1.27)	0.94 (0.56-1.53)
- Change sterilizing solutions (n=149)	0.81 (0.23-2.21)	0.74 (0.40-1.3)	1.00 (0.62-1.57)	0.69 (0.39-1.18)	0.63 (0.32-1.15)
- Manually sterilise or high-level disinfect (n=141)	3.61 (1.47-8.73)**	1.85 (1.10-3.07)*	1.87 (1.20-2.89)**	1.64 (1.00-2.62)*	1.45 (0.84-2.45)
- Sterilise instruments with automated systems (n=13)	11.22 (2.31-42.53)**	4.53 (1.33-14.04)*	5.95 (1.93-20.13)**	8.05 (2.60-27.31)**	4.01 (1.17-12.50)*
Training on adverse health effects due to cleaning agents (n=218)	0.34 (0.08-1.04)	0.84 (0.50-1.38)	0.71 (0.45-1.11)	0.54 (0.31-0.89)*	0.58 (0.31-1.00)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; *: P -value < 0.05; **: P -value < 0.01

NC: not calculable; WRSS: work-related skin symptoms

Each OR represents a separate regression model adjusted for host-related factors (family history of allergy to any substance and personal domestic cleaning frequency ≥ 1 time / week). Reference group of comparison was those workers who reported that they were not performing the task.

SECTION D: APPENDICES

APPENDIX 1: SUPPLEMENTARY TABLES

Supplementary Table 1: Nature of occupational exposures of health workers in the two tertiary hospitals

	SAHWs n (%)	TAHWs n (%)	Total N (%)
Wet work			
- Frequency of handwashes/day (≥ 10 times / day)	341 (99.1)	301 (85.3)	642 (92.1)
Work activity			
- Hand washing / sanitising	344 (100.0)	353 (100.0)	697 (100.0)
- Fixed surfaces cleaning and disinfection	321 (93.3)	251 (71.1)	572 (82.1)
- Patients' skin / wound cleaning and disinfection	234 (68.0)	93 (26.3)	327 (46.9)
- Medical instruments cleaning and disinfection	154 (44.8)	147 (41.6)	301 (43.2)
- Specimen preparation	102 (29.7)	55 (15.6)	157 (22.5)
Cleaning agent use (by work activity)			
Medical instruments cleaning and disinfection			
- Bleach	58 (16.9)	146 (41.4)	204 (29.3)
- All-purpose cleaner	-	132 (37.4)	-
- Enzymatic cleaners	71 (20.6)	42 (11.9)	113 (16.2)
- Ortho-phthalaldehyde (OPA)	75 (21.8)	38 (10.8)	113 (16.2)
- Chlorhexidine	84 (24.4)	-	-
- Glutaraldehyde	2 (0.6)	47 (13.3)	49 (7.0)
- Hydrogen peroxide	23 (6.7)	17 (4.8)	40 (5.7)
Fixed surfaces cleaning and disinfection			
- Bleach	253 (73.5)	221 (62.6)	474 (68.0)
- All-purpose cleaner	-	202 (57.2)	-
- Dishwashing liquid	138 (40.1)	-	-
- Ammonia	73 (21.2)	-	-
- Enzymatic cleaners	27 (7.9)	15 (4.3)	42 (6.0)
Specimen preparation			
- Formalin 10% solution	92 (26.7)	56 (15.9)	148 (21.2)
Patients' skin / wound cleaning and disinfection			
- Chlorhexidine	65 (18.9)	-	-
- Povidone iodine	49 (14.2)	-	-
Hand washing / sanitising			
- Chlorhexidine	337 (98.0)	-	-
- Liquid hand soap	305 (88.7)	-	-
- Hand wash liquid soap	-	235 (66.6)	-
- All-purpose cleaner (diluted)	-	153 (43.3)	-
- Alcohol sanitiser	-	79 (22.4)	-
Job task (by work activity)			
Medical instruments cleaning and disinfection			
- Prepare cleaning solutions (diluting or mixing)	163 (47.4)	88 (24.9)	251 (36.0)
- Manually disassemble instruments or remove gross contaminants	122 (35.5)	80 (22.7)	202 (29.0)
- Change sterilizing solutions	83 (24.1)	74 (21.0)	157 (22.5)
- Manually sterilise or high-level disinfect	109 (31.7)	34 (9.6)	143 (20.5)
- Sterilise instruments with automated systems	16 (4.7)	-	-
Fixed surfaces cleaning and disinfection			
- Use more wipes vs more sprays	184 (53.5)	268 (75.9)	452 (64.8)
- Clean instruments or equipment	267 (77.6)	136 (38.5)	403 (57.8)

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- Clean up blood and spills	250 (72.7)	127 (36.0)	377 (54.1)
- Manually mix, refill, or empty cleaning/disinfecting products	246 (71.5)	107 (30.3)	353 (50.6)
- Terminal cleaning of patient rooms	144 (41.9)	11 (3.1)	155 (22.2)
- Clean bathrooms	44 (12.8)	60 (17.0)	104 (14.9)
Patients' skin / wound cleaning and disinfection			
- Use adhesives	213 (61.9)	64 (18.1)	277 (39.7)
- Disinfect skin areas on patients prior to procedure	176 (51.2)	75 (21.2)	251 (36.0)
- Use adhesive removing solvents	194 (56.4)	2 (0.6)	196 (28.1)
- Clean and disinfect wounds	136 (39.5)	25 (7.1)	161 (23.1)
- Apply wound dressing	124 (36.0)	19 (5.4)	143 (20.5)

SAHWs – South African health workers, TAHWs – Tanzanian health workers

Supplementary Table 2: Occupational exposure duration of health workers in the two tertiary hospitals

	SAHWs Median (IQR)	TAHWs Median (IQR)	Total Median (IQR)
Duration of chemical agent exposure by work activity (min/week):			
Fixed surfaces cleaning and disinfection			
- Bleach	60 (25-150)	150 (75-240)	100 (47.5-200)
- Enzymatic cleaners	27.5 (17.5-150)	75 (45-95)	60 (25-138)
- All-purpose cleaner	-	150 (75-240)	-
- Ammonia	28 (10-120)	-	-
- Dishwashing liquid	20 (10-50)	-	-
Patients' skin / wound cleaning and disinfection			
- Povidone iodine	106 (60-182)	-	-
- Chlorhexidine	35 (10-80)	-	-
Medical instruments cleaning and disinfection			
- Enzymatic cleaners	75 (20-345)	122 (46.2-300)	90 (30-300)
- Bleach	28 (15-60)	108 (50-300)	75 (30-240)
- Glutaraldehyde	22 (13-31)	55 (30-172)	50 (27.5-158)
- Ortho-phthalaldehyde	22 (7.25-100)	55 (21.2-150)	30 (10-142)
- Hydrogen peroxide	10 (7-35)	40 (30-75)	27.5 (10-60)
- All-purpose cleaner	-	100 (60-240)	-
- Chlorhexidine	25 (7-60)	-	-
Specimen preparation			
- Formalin 10% solution	4 (2-10)	30 (15-57.5)	10 (3-30)
Duration of job task exposure by work activity (mins/week):			
Fixed surfaces cleaning and disinfection			
- Clean instruments or equipment	50 (24-125)	90 (50-220)	67 (30-150)
- Terminal cleaning of patient rooms	40 (20-76.2)	150 (71.2-176)	45 (20-100)
- Manually mix, refill, or empty cleaning/disinfecting products	10 (5-30)	25 (15-30)	20 (6-30)
Patients' skin / wound cleaning and disinfection			
- Disinfect skin areas on patients prior to procedure	30 (10-80)	125 (60-236)	60 (15-150)
- Clean and disinfect wounds	49 (20-120)	70 (35-120)	50 (20-120)
- Apply wound dressing	20 (5.5-100)	40 (37.5-52.5)	40 (8.5-100)
- Use adhesive removing solvents	30 (12-60)	150 (125-175)	32 (12-60)
- Use adhesives	24 (10-50)	50 (26.2-92)	30 (12-60)
Medical instruments cleaning and disinfection			
- Manually disassemble instruments or remove gross contaminants	45 (20-116)	90 (30-220)	54 (20-160)
- Manually sterilise or high-level disinfect	30 (9-80)	22.5 (10-130)	30 (9-100)
- Prepare cleaning solutions (diluting or mixing)	10 (5-45)	25 (10-50)	20 (5-45)
- Change sterilizing solutions	20 (8.5-53)	10 (5-25)	15 (5-40)
- Sterilise instruments with automated systems	90 (37.5-188)	-	-

SAHWs – South African health workers, TAHWs – Tanzanian health workers

IQR: interquartile range

Supplementary Table 3: Frequency of chemical agent exposure of health workers in the two tertiary hospitals

	SAHWs Median (IQR)	TAHWs Median (IQR)	Total Median (IQR)
Hand washing / sanitizing (times/day)			
- Chlorhexidine	40 (18-60)	-	-
- All-purpose cleaner (diluted)	-	15 (10-20)	-
- Alcohol sanitiser	-	10 (10-20)	-
- Hand wash liquid soap	-	10 (8-20)	-
- Liquid hand soap	8.5 (4-24.2)	-	-
Fixed surfaces cleaning and disinfection (days/week)			
- Bleach	4 (2-5)	5 (5-6)	5 (3-5)
- Dishwashing liquid	5 (4-5)	-	-
- Enzymatic cleaner	5 (2.75-5)	5 (5-5.5)	5 (5-5)
- All-purpose cleaner	-	5 (5-6)	-
- Ammonia	4 (1-5)	-	-
Patients' skin / wound cleaning and disinfection (days/week)			
- Chlorhexidine	4 (2-5)	-	-
- Povidone iodine	4 (2-5)	-	-
Medical instruments cleaning and disinfection (days/week)			
- Bleach	4 (3-5)	5 (4-6)	5 (4-5)
- Enzymatic cleaners	4 (2-5)	5 (3-5)	4 (3-5)
- Ortho-phthalaldehyde	3.5 (1.75-5)	5 (3-5)	4 (2-5)
- Hydrogen peroxide	1 (1-3)	4 (3-5)	2.5 (1-5)
- Chlorhexidine	5 (1-5)	-	-
- All-purpose cleaner	-	5 (5-6)	-
- Glutaraldehyde	3 (2.5-3.5)	2 (1-5)	2 (1-5)
Specimen preparation (days/week)			
- Formalin 10% solution	2 (1-5)	3 (2-5)	3 (2-5)

SAHWs – South African health workers, TAHWs – Tanzanian health workers

IQR: interquartile range

Supplementary Table 4: Frequency of exposure by job task of health workers in the two tertiary hospitals

		SAHWs Median (IQR)	TAHWs Median (IQR)	Total Median (IQR)
Medical instruments cleaning and disinfection				
- Manually disassemble instruments or remove gross contaminants	Days/week	4 (2-5)	3 (2-5)	4 (2-5)
	Times/day	2 (1-4)	2 (1-3)	2 (1-4)
- Prepare cleaning solutions (diluting or mixing)	Days/week	4 (2-5)	5 (2.8-6)	5 (2-5)
	Times/day	1 (1-2)	1 (1-1)	1 (1-2)
- Change sterilizing solutions	Days/week	4 (2-5)	2 (1-5)	3 (1-5)
	Times/day	1 (1-2)	1 (1-1)	1 (1-2)
- Manually sterilise or high-level disinfection	Days/week	4 (2-5)	2 (1-5)	3 (1-5)
	Times/day	2 (1-5)	1 (1-3.5)	2 (1-4)
- Sterilise instruments with automated systems	Days/week	4 (3-5)	-	-
	Times/day	4 (1-5.5)	-	-
Fixed surfaces cleaning and disinfection				
- Manually mix, refill, or empty cleaning/disinfecting products	Days/week	4 (3-5)	5 (3-6)	4.5 (3-5)
	Times/day	1 (1-2)	1 (1-1)	1 (1-2)
- Clean instruments or equipment	Days/week	4 (3-5)	5 (4-5)	5 (4-5)
	Times/day	2 (1-5)	1 (1-2)	2 (1-4)
- Terminal cleaning of patient rooms	Days/week	2 (1-4)	5 (3.3-5)	2.5 (1-4)
	Times/day	1 (1-2)	2 (1-2)	1 (1-2)
Patients' skin/wound cleaning and disinfection				
- Disinfect skin areas on patients prior to procedure	Days/week	4 (2-5)	5 (5-5)	4 (3-5)
	Times/day	2 (1-4)	5.5 (3-10)	3 (1.25-7)
- Clean and disinfect wounds	Days/week	3.5 (2-4)	3 (2-5)	3 (2-5)
	Times/day	2 (1-4)	1 (1-3)	2 (1-4)
- Apply wound dressing	Days/week	2 (1-5)	2 (2-4)	2 (1-5)
	Times/day	1 (1-3)	1 (1-1.5)	1 (1-2)
- Use adhesives	Days/week	4 (3-5)	5 (5-5)	5 (4-5)
	Times/day	3 (1-6)	7.5 (3.3-10)	4 (2-8)
- Use adhesive removing solvents	Days/week	4 (3-5)	5 (5-5)	5 (4-5)
	Times/day	4 (2-10)	4 (4-4)	4 (2-10)

SAHWs – South African health workers, TAHWs – Tanzanian health workers
IQR: interquartile range

Supplementary Table 5: Occupational health and safety activities of health workers in the two tertiary hospitals

Activity	SAHWs n (%)	TAHWs n (%)	Total N (%)
Glove usage for medical instruments cleaning and disinfection	209 (60.8)	112 (31.7)	321 (46.1)
- Prepare cleaning solutions (diluting or mixing)	144 (41.9)	88 (24.9)	232 (33.3)
- Manually disassemble instruments or remove gross contaminants	116 (33.7)	79 (22.4)	195 (28.0)
- Change sterilizing solutions	75 (21.8)	74 (21.0)	149 (21.4)
- Manually sterilise or high-level disinfect	107 (31.1)	34 (9.6)	141 (20.2)
- Sterilise instruments with automated systems	13 (3.8)	-	-
Training on adverse health effects of cleaning agents	81 (23.5)	137 (38.8)	218 (31.3)

SAHWs – South African health workers, TAHWs – Tanzanian health workers

Supplementary Table 6: Association between nature of occupational exposures and general skin outcomes in unadjusted logistic regression models

Unadjusted odds ratio (95% Confidence Interval)								
	Two or more skin symptoms in the last 12 months	Itchy/scratchy skin affecting the hands	Hives (“bommels”) affecting the hands	Dry/scaly skin affecting the hands	Redness of the skin affecting the hands	Blisters or weeping skin affecting the hands	Burning skin affecting the hands	Rash within an hour of contact with a rubber latex product
<i>Wet work</i>	2.96 (1.18 – 9.93)*	1.51 (0.59 – 5.11)	NC	0.51 (0.08 – 9.71)	3.97 (0.84 – 71.09)	NC	2.01 (0.41 – 36.24)	NC
<i>Workplace activity:</i>								
- Hand washing / sanitising	NC	NC	NC	NC	NC	NC	NC	NC
- Fixed surfaces cleaning and disinfection	1.37 (0.81 – 2.42)	0.99 (0.54 – 1.94)	1.43 (0.39 – 9.22)	1.31 (0.22 – 24.94)	1.20 (0.55 – 2.99)	0.87 (0.22 – 5.83)	NC	NC
- Patients’ skin / wound cleaning and disinfection	1.76 (1.19 – 2.61)**	1.38 (0.85 – 2.27)	1.72 (0.61 – 5.17)	0.45 (0.06 – 2.10)	2.98 (1.57 – 5.98)**	2.68 (0.74 – 12.50)	5.96 (2.23 – 20.66)**	8.07 (0.99 – 65.96)
- Medical instruments cleaning and disinfection	0.85 (0.57 – 1.26)	0.88 (0.53 – 1.43)	1.15 (0.40 – 3.25)	0.99 (0.19 – 4.51)	1.06 (0.57 – 1.94)	0.88 (0.22 – 3.09)	0.94 (0.40 – 2.13)	2.21 (0.54 – 10.86)
- Specimen preparation	1.36 (0.87 – 2.11)	1.17 (0.65 – 2.02)	1.26 (0.34 – 3.73)	1.38 (0.2 – 6.47)	1.27 (0.62 – 2.46)	1.48 (0.32 – 5.40)	1.44 (0.55 – 3.39)	5.89 (1.43 – 28.97)*
<i>Cleaning agent use (by workplace activity):</i>								
Medical instruments cleaning and disinfection:								
- Bleach	0.72 (0.46 – 1.12)	0.66 (0.36 – 1.16)	0.60 (0.14 – 1.91)	1.82 (0.36 – 8.35)	0.35 (0.13 – 0.79)*	1.04 (0.22 – 3.77)	0.21 (0.03 – 0.73)*	2.44 (0.57 – 10.43)
- All-purpose cleaner	0.49 (0.26 – 0.85)	0.84 (0.42 – 1.56)	0.65 (0.10 – 2.40)	1.72 (0.24 – 8.09)	0.29 (0.07 – 0.81)*	1.07 (0.16 – 4.34)	0.18 (0.02 – 1.34)	0.61 (0.03 – 3.46)
- Enzymatic cleaners	1.38 (0.83 – 2.23)	1.16 (0.59 – 2.13)	0.79 (0.12 – 2.92)	2.09 (0.3 – 9.81)	0.95 (0.38 – 2.06)	1.30 (0.19 – 5.26)	1.03 (0.30 – 2.80)	5.32 (1.24 – 22.81)*
- Ortho-phthalaldehyde (OPA)	1.38 (0.83 – 2.23)	1.42 (0.75 – 2.54)	1.91 (0.52 – 5.70)	NC	1.74 (0.82 – 3.45)	0.57 (0.03 – 3.08)	1.38 (0.45 – 3.51)	3.16 (0.64 – 13.06)
- Chlorhexidine	1.29 (0.72 – 2.22)	0.90 (0.39 – 1.85)	1.13 (0.17 – 4.17)	NC	1.92 (0.84 – 3.99)	0.81 (0.04 – 4.38)	1.48 (0.42 – 4.04)	2.47 (0.36 – 10.91)
- Glutaraldehyde	0.50 (0.17 – 1.18)	0.55 (0.13 – 1.55)	0.94 (0.05 – 4.85)	5.47 (0.77 – 26.14)	NC	NC	0.57 (0.03 – 2.78)	0.57 (0.03 – 2.78)
- Hydrogen peroxide	1.35 (0.59 – 2.81)	2.32 (0.96 – 5.02)	1.18 (0.06 – 6.09)	NC	2.20 (0.73 – 5.48)	4.27 (0.63 – 17.77)	0.71 (0.04 – 3.49)	5.71 (0.82 – 25.75)

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Fixed surfaces cleaning and disinfection:								
- Bleach	1.05 (0.69 – 1.60)	0.76 (0.46 – 1.28)	0.70 (0.25 – 2.11)	2.85 (0.48 – 53.92)	0.57 (0.31 – 1.05)	0.31 (0.08 – 1.09)	0.78 (0.34 – 1.88)	1.42 (0.32 – 9.72)
- All-purpose cleaner	0.53 (0.32 – 0.84)**	0.80 (0.45 – 1.37)	0.61 (0.14 – 1.93)	15.12 (2.56 – 286.58)*	0.16 (0.04 – 0.45)**	0.61 (0.09 – 2.46)	0.22 (0.03 – 0.74)*	0.35 (0.02 – 1.97)
- Dishwashing liquid	1.43 (0.90 – 2.24)	1.29 (0.70 – 2.25)	3.68 (1.27 – 10.43)*	NC	1.71 (0.85 – 3.29)	0.45 (0.02 – 2.40)	3.04 (1.28 – 6.95)**	1.36 (0.2 – 5.96)
- Ammonia	1.58 (0.87 – 2.75)	1.85 (0.91 – 3.52)	1.32 (0.20 – 4.92)	NC	1.95 (0.82 – 4.17)	0.95 (0.05 – 5.16)	3.79 (1.42 – 9.13)**	NC
- Enzymatic cleaners	1.47 (0.67 – 2.97)	1.19 (0.40 – 2.87)	1.12 (0.06 – 5.77)	2.64 (0.14 – 15.95)	0.71 (0.11 – 2.43)	4.04 (0.60 – 16.80)	1.44 (0.23 – 5.12)	2.26 (0.12 – 13.12)
Specimen preparation:								
- Formalin 10% solution	1.43 (0.90 – 2.21)	1.17 (0.64 – 2.04)	1.36 (0.37 – 4.04)	1.49 (0.21 – 6.99)	1.22 (0.58 – 2.39)	0.93 (0.14 – 3.75)	1.25 (0.45 – 3.03)	6.36 (1.54 – 31.32)*
Patients' skin / wound cleaning and disinfection:								
- Chlorhexidine	1.42 (0.75 – 2.57)	2.16 (1.05 – 4.14)*	2.50 (0.56 – 8.13)	NC	2.66 (1.15 – 5.59)*	4.32 (0.91 – 15.97)	6.61 (2.67 – 15.56)**	1.40 (0.07 – 8.01)
- Povidone iodine	1.36 (0.64 – 2.65)	1.23 (0.46 – 2.80)	0.94 (0.05 – 4.85)	NC	1.32 (0.38 – 3.45)	3.40 (0.50 – 14.06)	3.76 (1.20 – 9.88)*	8.39 (1.68 – 35.27)**
Hand washing / sanitising:								
- Chlorhexidine	2.09 (1.41 – 3.13)**	1.38 (0.85 – 2.27)	1.62 (0.58 – 4.88)	NC	3.56 (1.83 – 7.48)**	1.61 (0.46 – 6.36)	12.50 (3.65 – 78.42)**	7.62 (0.93 – 62.24)
- Liquid hand soap	2.52 (1.70 – 3.78)**	1.50 (0.92 – 2.45)	1.96 (0.70 – 5.89)	NC	3.84 (2.00 – 7.87)**	1.29 (0.36 – 4.68)	6.81 (2.54 – 23.60)**	3.91 (0.89 – 26.84)
- Hand wash liquid soap	0.46 (0.28 – 0.72)**	0.73 (0.42 – 1.24)	0.30 (0.05 – 1.08)	2.65 (0.58 – 13.54)	0.08 (0.01 – 0.27)**	0.84 (0.18 – 3.05)	0.17 (0.03 – 0.59)*	0.28 (0.01 – 1.57)
- All-purpose cleaner (diluted)	0.82 (0.49 – 1.31)	1.11 (0.61 – 1.94)	1.30 (0.36 – 3.87)	4.84 (1.06 – 24.80)*	1.02 (0.47 – 2.03)	0.89 (0.13 – 3.59)	NC	NC
- Alcohol sanitiser	0.16 (0.04 – 0.44)**	0.97 (0.45 – 2.11)	0.55 (0.03 – 2.81)	1.31 (0.07 – 7.79)	NC	NC	0.33 (0.02 – 1.61)	1.12 (0.06 – 6.41)
Job task (by workplace activity):								
Medical instruments cleaning and disinfection:								
- Prepare cleaning solutions (diluting or mixing)	1.34 (0.90 – 1.98)	0.88 (0.52 – 1.46)	0.44 (0.10 – 1.39)	0.71 (0.10 – 3.31)	1.20 (0.64 – 2.21)	0.19 (0.01 – 1.04)	0.72 (0.28 – 1.70)	5.44 (1.24 – 37.30)*

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- Manually disassemble instruments or remove gross contaminants	1.30 (0.86 – 1.96)	1.26 (0.74 – 2.09)	0.89 (0.24 – 2.63)	0.98 (0.14 – 4.59)	1.87 (1.00 – 3.45)*	0.61 (0.09 – 2.46)	1.01 (0.39 – 2.38)	1.48 (0.30 – 6.08)
- Change sterilizing solutions	0.83 (0.51 – 1.33)	0.74 (0.38 – 1.34)	0.24 (0.01 – 1.21)	1.38 (0.20 – 6.47)	0.85 (0.38 – 1.73)	0.86 (0.13 – 3.47)	0.30 (0.05 – 1.05)	2.08 (0.42 – 8.59)
- Manually sterilise or high-level disinfect	1.76 (1.12 – 2.71)*	1.83 (1.05 – 3.11)*	1.97 (0.61 – 5.64)	0.64 (0.03 – 3.81)	3.44 (1.83 – 6.38)*	0.97 (0.15 – 3.92)	2.41 (0.99 – 5.54)	3.96 (0.93 – 16.92)
- Sterilise instruments with automated systems	2.83 (0.95 – 7.78)	4.17 (1.28 – 11.83)*	7.34 (1.08 – 30.09)*	NC	2.12 (0.33 – 7.91)	12.02 (1.71 – 53.63)**	7.25 (1.58 – 24.64)**	6.42 (0.33 – 39.43)
Fixed surfaces cleaning and disinfection:								
- Use more wipes vs more sprays	1.00 (0.67 – 1.50)	1.17 (0.70 – 2.01)	1.09 (0.38 – 3.52)	3.28 (0.56 – 62.18)	0.80 (0.43 – 1.51)	0.81 (0.23 – 3.20)	0.90 (0.39 – 2.17)	0.90 (0.22 – 4.43)
- Clean instruments or equipment	1.56 (1.04 – 2.35)*	1.16 (0.71 – 1.94)	2.03 (0.69 – 7.40)	0.54 (0.11 – 2.48)	1.67 (0.89 – 3.29)	1.71 (0.47 – 8.01)	3.79 (1.41 – 13.12)*	5.18 (0.91 – 97.08)
- Clean up blood and spills	1.45 (0.98 – 2.17)	1.21 (0.74 – 2.00)	0.42 (0.13 – 1.19)	1.13 (0.25 – 5.79)	1.58 (0.85 – 3.04)	7.80 (1.45 – 144.27)*	4.43 (1.65 – 15.34)*	1.42 (0.35 – 6.97)
- Manually mix, refill, or empty cleaning/disinfecting products	1.35 (0.92 – 2.00)	0.97 (0.60 – 1.59)	0.48 (0.15 – 1.37)	0.73 (0.14 – 3.33)	1.36 (0.74 – 2.54)	1.47 (0.42 – 5.79)	3.03 (1.25 – 8.43)*	2.96 (0.68 – 20.28)
- Terminal cleaning of patient rooms	1.46 (0.94 – 2.26)	0.83 (0.43 – 1.49)	1.28 (0.35 – 3.80)	NC	1.14 (0.54 – 2.24)	NC	1.79 (0.71 – 4.15)	NC
- Clean bathrooms	0.61 (0.32 – 1.10)	0.59 (0.24 – 1.23)	0.40 (0.02 – 2.03)	NC	NC	0.63 (0.03 – 3.40)	NC	0.81 (0.04 – 4.63)
Patients' skin / wound cleaning and disinfection:								
- Use adhesives	2.07 (1.40 – 3.07)**	1.59 (0.98 – 2.60)	1.75 (0.62 – 5.06)	0.25 (0.01 – 1.47)	3.65 (1.94 – 7.21)**	2.30 (0.65 – 9.08)	6.11 (2.42 – 18.62)**	NC
- Disinfect skin areas on patients prior to procedure	1.92 (1.29 – 2.84)**	2.03 (1.24 – 3.33)**	2.06 (0.73 – 5.95)	0.71 (0.10 – 3.31)	3.90 (2.09 – 7.59)**	2.71 (0.77 – 10.67)	7.22 (2.86 – 22.01)**	5.44 (1.24 – 37.30)*
- Use adhesive removing solvents	1.64 (1.08 – 2.46)*	1.32 (0.77 – 2.20)	2.28 (0.79 – 6.44)	NC	2.38 (1.29 – 4.39)**	0.64 (0.10 – 2.56)	6.70 (2.84 – 17.58)**	1.54 (0.31 – 6.35)
- Clean and disinfect wounds	1.45 (0.93 – 2.22)	1.12 (0.62 – 1.94)	0.51 (0.08 – 1.86)	NC	1.38 (0.69 – 2.65)	2.25 (0.57 – 7.98)	2.47 (1.05 – 5.63)*	3.39 (0.79 – 14.48)
- Apply wound dressing	1.67 (1.06 – 2.59)*	1.57 (0.89 – 2.69)	0.97 (0.22 – 3.10)	NC	1.83 (0.92 – 3.48)	6.02 (1.70 – 23.83)*	2.90 (1.23 – 6.63)*	2.35 (0.48 – 9.70)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; NC: not calculable; *: P -value < 0.05; **: P -value < 0.01

Each OR represents a separate unadjusted regression model. Reference group of comparison are those workers who reported that they were not using the chemical or were not performing the task.

Supplementary Table 7: Association between nature of occupational exposures and work-related skin outcomes in unadjusted logistic regression models

Unadjusted odds ratio (95% Confidence Interval)					
	Probable contact urticaria	Probable contact dermatitis	WRSS ever	WRSS in the last 12 months (Definition 1)	WRSS in the last 12 months (Definition 2)
Wet work	NC	1.87 (0.74 – 6.29)	1.63 (0.76 – 4.01)	1.45 (0.65 – 3.87)	1.32 (0.56 – 3.90)
Workplace activity:					
- Hand washing / sanitising	NC	NC	0.99 (0.67 – 1.46)	0.77 (0.47 – 1.23)	0.77 (0.47 – 1.23)
- Fixed surfaces cleaning and disinfection	2.23 (0.64 – 14.07)	1.14 (0.64 – 2.18)	1.85 (1.07 – 3.41)*	1.61 (0.90 – 3.11)	2.47 (1.18 – 6.01)*
- Patients' skin / wound cleaning and disinfection	3.12 (1.27 – 8.79)*	1.59 (1.01 – 2.51)*	1.22 (0.77 – 1.88)	1.05 (0.63 – 1.71)	0.77 (0.41 – 1.36)
- Medical instruments cleaning and disinfection	1.60 (0.68 – 3.85)	0.94 (0.59 – 1.48)	2.64 (1.78 – 3.97)**	3.09 (1.98 – 4.91)**	2.98 (1.82 – 5.01)**
- Specimen preparation	2.47 (1.00 – 5.83)*	1.05 (0.60 – 1.76)	NC	NC	NC
Cleaning agent use (by workplace activity):					
Medical instruments cleaning and disinfection:					
- Bleach	0.90 (0.32 – 2.23)	0.70 (0.40 – 1.17)	0.43 (0.26 – 0.69)**	0.30 (0.16 – 0.54)**	0.35 (0.17 – 0.65)**
- All-purpose cleaner	0.42 (0.07 – 1.46)	0.66 (0.33 – 1.22)	0.23 (0.10 – 0.46)**	0.11 (0.03 – 0.29)**	0.10 (0.02 – 0.31)**
- Enzymatic cleaners	1.99 (0.70 – 4.96)	1.11 (0.59 – 1.96)	1.85 (1.15 – 2.93)*	1.11 (0.62 – 1.90)	0.80 (0.39 – 1.52)
- Ortho-phthalaldehyde (OPA)	2.51 (0.94 – 6.09)	1.44 (0.8 – 2.48)	1.56 (0.95 – 2.48)	1.30 (0.74 – 2.18)	1.00 (0.51 – 1.83)
- Chlorhexidine	1.65 (0.47 – 4.56)	1.21 (0.60 – 2.27)	1.78 (1.04 – 2.97)*	1.69 (0.94 – 2.94)	2.02 (1.07 – 3.62)*
- Glutaraldehyde	0.62 (0.03 – 3.07)	0.61 (0.18 – 1.56)	0.59 (0.22 – 1.32)	0.11 (0.01 – 0.52)*	0.15 (0.02 – 1.10)
- Hydrogen peroxide	3.94 (1.10 – 11.24)*	1.86 (0.77 – 3.99)	1.29 (0.56 – 2.67)	1.24 (0.49 – 2.73)	1.11 (0.37 – 2.68)
Fixed surfaces cleaning and disinfection:					
- Bleach	0.67 (0.28 – 1.65)	0.91 (0.57 – 1.49)	1.28 (0.85 – 1.98)	1.17 (0.75 – 1.87)	1.59 (0.94 – 2.79)
- All-purpose cleaner	0.38 (0.09 – 1.12)	0.71 (0.41 – 1.19)	0.36 (0.21 – 0.59)**	0.31 (0.16 – 0.55)**	0.36 (0.17 – 0.66)**
- Dishwashing liquid	2.40 (0.94 – 5.72)	1.36 (0.79 – 2.29)	1.84 (1.18 – 2.83)**	1.74 (1.07 – 2.79)*	1.64 (0.95 – 2.75)
- Ammonia	0.85 (0.13 – 3.00)	1.64 (0.82 – 3.04)	1.50 (0.83 – 2.60)	1.58 (0.83 – 2.84)	1.43 (0.68 – 2.74)
- Enzymatic cleaners	1.59 (0.25 – 5.70)	1.74 (0.73 – 3.72)	1.82 (0.87 – 3.58)	1.39 (0.58 – 2.95)	1.31 (0.48 – 3.00)
Specimen preparation:					
- Formalin 10% solution	2.67 (1.08 – 6.32)*	1.06 (0.60 – 1.80)	1.14 (0.71 – 1.78)	1.01 (0.59 – 1.66)	0.76 (0.40 – 1.36)
Patients' skin / wound cleaning and disinfection:					

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- Chlorhexidine	3.01 (0.96 – 7.93)	1.71 (0.84 – 3.24)	1.94 (1.07 – 3.39)*	2.25 (1.21 – 4.02)**	2.62 (1.35 – 4.82)**
- Povidone iodine	3.11 (0.87 – 8.76)	1.20 (0.48 – 2.61)	2.27 (1.18 – 4.21)*	1.99 (0.96 – 3.85)	1.83 (0.80 – 3.77)
Hand washing / sanitising:					
- Chlorhexidine	2.94 (1.19 – 8.28)*	1.57 (1.00 – 2.49)	3.18 (2.12 – 4.85)**	3.21 (2.05 – 5.15)**	3.43 (2.06 – 5.90)**
- Liquid hand soap	2.84 (1.18 – 7.53)*	1.65 (1.05 – 2.61)*	3.11 (2.09 – 4.67)**	3.08 (1.99 – 4.84)**	3.03 (1.86 – 5.03)**
- Hand wash liquid soap	0.19 (0.03 – 0.66)*	0.64 (0.38 – 1.06)	0.30 (0.17 – 0.48)**	0.22 (0.11 – 0.39)**	0.28 (0.14 – 0.52)**
- All-purpose cleaner (diluted)	0.78 (0.22 – 2.14)	1.09 (0.62 – 1.83)	0.44 (0.24 – 0.75)**	0.61 (0.34 – 1.05)	0.36 (0.16 – 0.73)**
- Alcohol sanitiser	0.36 (0.02 – 1.78)	0.25 (0.06 – 0.70)*	0.27 (0.09 – 0.61)**	0.13 (0.02 – 0.43)**	0.18 (0.03 – 0.59)*
Job task (by workplace activity):					
Medical instruments cleaning and disinfection:					
- Prepare cleaning solutions (diluting or mixing)	1.02 (0.40 – 2.41)	0.95 (0.58 – 1.51)	1.33 (0.90 – 1.97)	1.05 (0.67 – 1.61)	1.21 (0.75 – 1.94)
- Manually disassemble instruments or remove gross contaminants	1.42 (0.56 – 3.36)	1.21 (0.74 – 1.95)	1.38 (0.92 – 2.07)	1.32 (0.84 – 2.04)	1.29 (0.77 – 2.09)
- Change sterilizing solutions	0.76 (0.22 – 2.07)	0.70 (0.37 – 1.22)	1.04 (0.65 – 1.62)	0.75 (0.43 – 1.25)	0.64 (0.33 – 1.15)
- Manually sterilise or high-level disinfect	3.40 (1.41 – 8.04)**	1.95 (1.17 – 3.19)*	2.20 (1.43 – 3.36)**	1.96 (1.22 – 3.10)*	1.79 (1.05 – 2.98)*
- Sterilise instruments with automated systems	8.04 (1.74 – 27.58)**	3.37 (1.04 – 9.51)*	4.58 (1.66 – 12.68)*	6.17 (2.22 – 17.15)**	3.67 (1.13 – 10.40)*
Fixed surfaces cleaning and disinfection:					
- Use more wipes vs more sprays	1.17 (0.49 – 3.09)	1.07 (0.67 – 1.75)	0.66 (0.45 – 0.98)*	0.62 (0.41 – 0.96)*	0.63 (0.39 – 1.01)
- Clean instruments or equipment	3.39 (1.25 – 11.83)*	1.27 (0.80 – 2.04)	1.75 (1.17 – 2.64)*	2.06 (1.31 – 3.30)*	2.40 (1.43 – 4.16)**
- Clean up blood and spills	0.84 (0.36 – 2.00)	1.42 (0.90 – 2.28)	1.71 (1.16 – 2.55)*	1.47 (0.96 – 2.28)	1.67 (1.03 – 2.74)*
- Manually mix, refill, or empty cleaning/disinfecting products	0.81 (0.34 – 1.89)	1.14 (0.72 – 1.80)	1.79 (1.22 – 2.66)*	1.65 (1.08 – 2.55)*	1.83 (1.14 – 3.00)*
- Terminal cleaning of patient rooms	1.03 (0.33 – 2.65)	0.99 (0.56 – 1.68)	1.37 (0.88 – 2.11)	1.54 (0.95 – 2.44)	1.95 (1.16 – 3.19)*
- Clean bathrooms	0.26 (0.01 – 1.28)	NC	0.64 (0.34 – 1.13)	NC	NC
Patients' skin / wound cleaning and disinfection:					
- Use adhesives	3.38 (1.40 – 8.95)*	1.89 (1.20 – 2.99)*	3.01 (2.03 – 4.48)**	3.77 (2.43 – 5.93) **	3.91 (2.40 – 6.55) **
- Disinfect skin areas on patients prior to procedure	3.23 (1.37 – 8.20)*	2.28 (1.44 – 3.60)**	2.21 (1.50 – 3.26)**	2.81 (1.84 – 4.32)**	2.57 (1.60 – 4.14)**
- Use adhesive removing solvents	2.65 (1.12 – 6.29)*	1.44 (0.88 – 2.30)	2.31 (1.55 – 3.43)**	2.63 (1.71 – 4.04) **	3.52 (2.19 – 5.70) **
- Clean and disinfect wounds	1.58 (0.59 – 3.81)	1.17 (0.68 – 1.94)	1.56 (1.01 – 2.38)*	1.72 (1.08 – 2.70)*	2.23 (1.35 – 3.62) **

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- Apply wound dressing	1.85 (0.69 – 4.48)	1.49 (0.88 – 2.48)	2.00 (1.29 – 3.06)**	2.19 (1.37 – 3.45) **	2.85 (1.73 – 4.66) **
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Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; *: *P*-value < 0.05; **: *P*-value < 0.01

NC: not calculable; WRSS: work-related skin symptoms

Each OR represents a separate unadjusted regression model. Reference group of comparison are those workers who reported that they were not using the chemical or were not performing the task.

Supplementary Table 8: Association between duration and frequency of occupational exposures and skin outcomes in adjusted logistic regression models

Adjusted odds ratio (95% Confidence Interval)					
	Probable contact urticaria (n=22)	Probable contact dermatitis (n=86)	WRSS ever (n=130)	WRSS in the last 12 months (Definition 1) (n=103)	WRSS in the last 12 months (Definition 2) (n=80)
<i>Duration of chemical agent exposure by work activity:</i>					
Medical instruments cleaning and disinfection					
1-99 mins/week	2.53 (0.78-7.21)	0.65 (0.28-1.34)	1.28 (0.73-2.18)	0.89 (0.46-1.62)	0.99 (0.48-1.88)
≥ 100 mins/week	1.92 (0.64-5.21)	0.95 (0.52-1.66)	0.65 (0.37-1.12)	0.56 (0.29-1.02)	0.50 (0.22-1.00)
Fixed surfaces cleaning and disinfection					
1-99 mins/week	4.61 (1.71-13.66)**	1.61 (0.90-2.84)	1.47 (0.90-2.40)	1.38 (0.81-2.34)	1.55 (0.86-2.74)
≥ 100 mins/week	1.09 (0.31-3.66)	1.03 (0.60-1.74)	0.93 (0.59-1.45)	0.84 (0.51-1.37)	0.81 (0.45-1.41)
<i>Duration of job task exposure by work activity:</i>					
Medical instruments cleaning and disinfection					
1-99 mins/week	0.55 (0.12-1.83)	0.86 (0.49-1.47)	1.43 (0.92-2.21)	1.35 (0.83-2.16)	1.65 (0.98-2.76)
≥ 100 mins/week	2.72 (1.05-6.99)*	1.21 (0.66-2.14)	1.12 (0.65-1.88)	0.87 (0.47-1.56)	0.75 (0.35-1.49)
Fixed surfaces cleaning and disinfection					
1-99 mins/week	9.16 (2.31-60.81)*	1.37 (0.75-2.47)	0.87 (0.51-1.46)	0.98 (0.55-1.72)	1.03 (0.54-1.91)
≥ 100 mins/week	6.33 (1.68-41.22)*	1.26 (0.75-2.14)	1.10 (0.71-1.69)	1.12 (0.70-1.81)	1.08 (0.63-1.85)
<i>Frequency of chemical exposure by work activity:</i>					
Medical instruments cleaning and disinfection (days/week)	1.17 (0.96-1.41)	0.97 (0.86-1.09)	0.93 (0.83-1.03)	0.88 (0.78-0.99)	0.87 (0.75-1.00)
Fixed surfaces cleaning and disinfection (days/week)	1.11 (0.94-1.33)	1.05 (0.96-1.15)	1.01 (0.93-1.09)	0.97 (0.89-1.06)	0.97 (0.88-1.07)
Hand washing / sanitising (times/day)	1.02 (1.00-1.03)	1.00 (0.99-1.01)	1.01 (1.00-1.02)	1.01 (1.00-1.02)	1.01 (0.99-1.02)
<i>Frequency of job task exposure by work activity:</i>					
Medical instruments cleaning and disinfection					
- Days/week	1.15 (0.96-1.35)	1.02 (0.92-1.12)	1.04 (0.95-1.12)	1.00 (0.91-1.10)	1.02 (0.92-1.12)
- Times/day	1.06 (0.89-1.19)	0.98 (0.87-1.08)	1.05 (0.98-1.13)	1.03 (0.95-1.11)	1.04 (0.95-1.12)

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Fixed surfaces cleaning and disinfection					
- Days/week	1.33 (1.09-1.67)*	1.08 (0.98-1.20)	1.00 (0.91-1.09)	1.00 (0.91-1.11)	0.99 (0.89-1.11)
- Times/day	1.02 (0.88-1.09)	0.99 (0.89-1.05)	1.04 (0.99-1.09)	1.05 (0.99-1.11)	1.04 (0.99-1.10)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; *: P -value < 0.05; **: P -value < 0.01

NC: not calculable; WRSS: work-related skin symptoms

Each OR represents a separate regression model adjusted for host-related factors (family history of allergy to any substance and personal domestic cleaning frequency ≥ 1 time / week). Reference group of comparison were those workers who reported that they were not using the chemical or were not performing the task.

Supplementary Table 9: Association between occupational factors and work-related skin outcomes in secondary adjusted logistic regression models

Adjusted odds ratio (95% Confidence Interval)					
	Probable contact urticaria (n=22)	Probable contact dermatitis (n=86)	WRSS ever (n=130)	WRSS in the last 12 months (Definition 1) (n=103)	WRSS in the last 12 months (Definition 2) (n=80)
Job title					
- Clerk/Administrative	Reference	Reference	Reference	Reference	Reference
- Nursing (n=526)	0.51 (0.13-3.35)	1.14 (0.43-3.94)	1.85 (0.71-6.39)	1.39 (0.52-4.79)	1.45 (0.49-6.22)
Registered professional nurse (n=283)	0.53 (0.13-3.63)	1.30 (0.48-4.56)	2.26 (0.84-7.87)	1.77 (0.66-6.20)	1.75 (0.58-7.57)
Nursing assistant (n=168)	0.29 (0.04-2.27)	0.79 (0.26-2.94)	1.25 (0.43-4.56)	0.92 (0.31-3.41)	1.14 (0.34-5.18)
Enrolled nurse (n=75)	0.92 (0.17-6.93)	1.33 (0.41-5.12)	1.70 (0.55-6.43)	1.01 (0.30-3.98)	1.05 (0.27-5.18)
- Cleaner (n=85)	0.19 (0.01-2.10)	0.77 (0.22-3.12)	1.57 (0.51-5.93)	0.91 (0.27-3.61)	0.83 (0.20-4.14)
- Technician (n=34)	1.94 (0.29-16.20)	4.77 (1.40-19.41)*	5.38 (1.62-21.63)*	3.95 (1.16-15.99)*	4.81 (1.28-23.62)*
- Porter (n=14)	NC	NC	0.60 (0.03-4.84)	0.61 (0.03-4.99)	NC
Employment duration					
- Duration in health work	1.00 (0.93-1.09)	1.03 (0.98-1.08)	1.03 (0.99-1.07)	1.03 (0.99-1.07)	1.02 (0.98-1.07)
- Duration in department	1.02 (0.96-1.09)	1.02 (0.98-1.05)	1.03 (1.00-1.06)	1.02 (0.99-1.05)	1.03 (0.99-1.06)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; NC: not calculable; WRSS: work-related skin symptoms

Each OR represents a separate regression model adjusted for host-related factors (age, gender, atopy, family history of allergy to any substance, and personal domestic cleaning frequency ≥ 1 time / week).

Supplementary Table 10: Association between nature of occupational exposures and work-related skin outcomes in secondary adjusted logistic regression models

Adjusted odds ratio (95% Confidence Interval)					
	Probable contact urticaria (n=22)	Probable contact dermatitis (n=86)	WRSS ever (n=130)	WRSS in the last 12 months (Definition 1) (n=103)	WRSS in the last 12 months (Definition 2) (n=80)
Wet work:					
- Handwash frequency \geq 10 times/day (n=642)	NC	1.87 (0.73-6.33)	1.48 (0.68-3.70)	1.32 (0.58-3.55)	1.23 (0.51-3.65)
Workplace activity:					
- Hand washing / sanitising (n=697)	NC	NC	NC	NC	NC
- Fixed surfaces cleaning and disinfection (n=572)	2.11 (0.59-13.55)	1.06 (0.59-2.06)	1.60 (0.91-2.99)	1.40 (0.77-2.75)	2.15 (1.01-5.30)*
- Patients' skin / wound cleaning and disinfection (n=327)	3.08 (1.23-8.78)*	1.58 (0.99-2.53)	2.44 (1.63-3.69)**	2.86 (1.82-4.58)**	2.74 (1.66-4.65)**
- Medical instruments cleaning and disinfection (n=301)	1.69 (0.71-4.12)	0.91 (0.57-1.45)	0.98 (0.66-1.46)	0.75 (0.48-1.17)	0.73 (0.44-1.19)
- Specimen preparation (n=157)	2.62 (1.04-6.39)*	0.99 (0.56-1.69)	1.08 (0.68-1.69)	0.93 (0.55-1.53)	0.65 (0.34-1.17)
Cleaning agent use (by workplace activity):					
Medical instruments cleaning and disinfection					
- Enzymatic cleaners (n=113)	2.06 (0.72-5.21)	1.07 (0.57-1.91)	1.75 (1.07-2.80)*	1.03 (0.57-1.77)	0.72 (0.35-1.37)
- Ortho-phthalaldehyde (n=113)	2.64 (0.98-6.52)	1.42 (0.78-2.46)	1.49 (0.90-2.41)	1.23 (0.70-2.09)	0.92 (0.47-1.70)
- Chlorhexidine (n=84)	1.67 (0.46-4.78)	1.14 (0.56-2.16)	1.46 (0.84-2.47)	1.40 (0.77-2.47)	1.66 (0.87-3.02)
- Hydrogen peroxide (n=40)	4.21 (1.16-12.25)*	1.83 (0.76-3.95)	1.33 (0.58-2.82)	1.29 (0.50-2.88)	1.13 (0.37-2.77)
- Bleach (n=204)	0.93 (0.32-2.32)	0.69 (0.40-1.17)	0.47 (0.28-0.76)**	0.33 (0.17-0.60)**	0.38 (0.19-0.72)*
- All-purpose cleaner (n=132)	0.42 (0.06-1.50)	0.66 (0.32-1.23)	0.28 (0.12-0.56)**	0.13 (0.03-0.36)**	0.11 (0.02-0.38)**
- Glutaraldehyde (n=49)	0.62 (0.03-3.10)	0.60 (0.18-1.54)	0.61 (0.23-1.38)	0.11 (0.01-0.54)*	0.15 (0.01-0.73)*
Fixed surfaces cleaning and disinfection					
- Bleach (n=474)	0.63 (0.27-1.57)	0.89 (0.55-1.45)	1.23 (0.81-1.92)	1.14 (0.72-1.84)	1.56 (0.92-2.77)
- Ammonia (n=73)	0.80 (0.12-2.87)	1.56 (0.78-2.93)	1.26 (0.69-2.22)	1.36 (0.71-2.47)	1.22 (0.58-2.37)
- Dishwashing liquid (n=138)	2.31 (0.88-5.69)	1.31 (0.75-2.23)	1.59 (1.01-2.47)*	1.52 (0.92-2.46)	1.42 (0.81-2.41)
- All-purpose cleaner (n=202)	0.37 (0.08-1.11)	0.71 (0.41-1.21)	0.41 (0.24-0.69)**	0.35 (0.18-0.64)*	0.41 (0.20-0.77)*
- Enzymatic cleaners (n=42)	1.59 (0.25-5.75)	1.73 (0.72-3.71)	1.93 (0.91-3.85)	1.45 (0.60-3.13)	1.36 (0.50-3.16)
Specimen preparation					

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- Formalin 10% solution (n=148)	2.82 (1.12-6.85)*	1.01 (0.57-1.73)	1.03 (0.63-1.62)	0.90 (0.52-1.50)	0.66 (0.34-1.19)
Patients' skin / wound cleaning and disinfection					
- Chlorhexidine (n=65)	3.05 (0.96-8.27)	1.65 (0.80-3.17)	1.62 (0.89-2.87)	1.90 (1.01-3.44)*	2.20 (1.12-4.10)*
- Povidone iodine (n=49)	3.01 (0.83-8.72)	1.14 (0.45-2.51)	1.97 (1.01-3.69)*	1.75 (0.84-3.44)	1.63 (0.71-3.41)
Hand washing / sanitising					
- Chlorhexidine (n=337)	NC	NC	0.55 (0.12-2.91)	0.78 (0.16-5.65)	0.58 (0.12-4.17)
- Liquid hand soap (n=305)	3.08 (1.21-8.68)*	1.64 (1.01-2.68)*	2.59 (1.71-3.96)**	2.59 (1.64-4.16)**	2.52 (1.52-4.29)**
- Alcohol sanitiser (n=79)	0.37 (0.02-1.83)	0.26 (0.06-0.71)*	0.30 (0.10-0.69)*	0.15 (0.02-0.48)*	0.20 (0.03-0.66)*
- All-purpose cleaner (diluted) (n=153)	0.77 (0.21-2.21)	1.21 (0.68-2.08)	0.51 (0.28-0.89)*	0.70 (0.38-1.25)	0.41 (0.18-0.85)*
- Hand wash liquid soap (n=235)	0.17 (0.02-0.62)*	0.61 (0.35-1.05)	0.36 (0.20-0.59)**	0.26 (0.13-0.48)**	0.33 (0.16-0.64)**
<i>Job task (by workplace activity):</i>					
Medical instruments cleaning and disinfection					
- Manually disassemble instruments or remove gross contaminants (n=202)	1.43 (0.56-3.42)	1.05 (0.66-1.68)	1.26 (0.83-1.90)	1.20 (0.76-1.88)	1.16 (0.7-1.91)
- Prepare cleaning solutions (diluting or mixing) (n=251)	0.98 (0.38-2.35)	0.90 (0.55-1.45)	1.20 (0.81-1.79)	0.94 (0.60-1.46)	1.09 (0.67-1.77)
- Change sterilizing solutions (n=157)	0.75 (0.21-2.07)	0.67 (0.36-1.18)	0.94 (0.59-1.48)	0.66 (0.38-1.12)	0.56 (0.28-1.02)
- Manually sterilise or high-level disinfect (n=143)	3.58 (1.44-8.77)**	1.90 (1.13-3.15)*	1.91 (1.22-2.94)**	1.68 (1.03-2.69)*	1.50 (0.87-2.53)
- Sterilise instruments with automated systems (n=16)	8.78 (1.86-31.41)**	3.39 (1.04-9.68)*	4.04 (1.43-11.44)*	5.48 (1.93-15.65)**	3.14 (0.95-9.14)
Fixed surfaces cleaning and disinfection					
- Use more wipes vs more sprays (n=452)	1.16 (0.48-3.09)	1.07 (0.67-1.76)	0.69 (0.47-1.03)	0.65 (0.42-1.00)	0.65 (0.40-1.05)
- Manually mix, refill, or empty cleaning/disinfecting products (n=353)	0.75 (0.30-1.80)	1.07 (0.67-1.72)	1.52 (1.02-2.29)*	1.41 (0.91-2.21)	1.56 (0.96-2.60)
- Clean instruments or equipment (n=403)	3.32 (1.21-11.65)*	1.24 (0.78-2.01)	1.62 (1.08-2.46)*	1.91 (1.21-3.09)*	2.23 (1.32-3.89)**
- Terminal cleaning of patient rooms (n=155)	0.96 (0.31-2.53)	0.95 (0.53-1.62)	1.17 (0.74-1.81)	1.33 (0.82-2.13)	1.70 (1.01-2.81)*
- Clean up blood and spills (n=377)	0.83 (0.35-1.98)	1.39 (0.87-2.24)	1.55 (1.04-2.33)*	1.33 (0.86-2.08)	1.50 (0.92-2.48)
- Clean bathrooms (n=104)	0.26 (0.01-1.26)	0.47 (0.19-0.97)	0.64 (0.34-1.13)	0.50 (0.23-0.98)	0.43 (0.16-0.95)
Patients' skin / wound cleaning and disinfection					

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- Disinfect skin areas on patients prior to procedure (n=251)	3.19 (1.33-8.19)*	2.29 (1.44-3.67)**	2.02 (1.36-3.00)**	2.60 (1.69-4.03)**	2.36 (1.46-3.84)**
- Clean and disinfect wounds (n=161)	1.53 (0.57-3.73)	1.14 (0.66-1.90)	1.49 (0.96-2.29)	1.66 (1.03-2.63)*	2.16 (1.30-3.55)**
- Apply wound dressing (n=143)	1.80 (0.67-4.42)	1.45 (0.85-2.42)	1.88 (1.20-2.89)**	2.08 (1.29-3.31)**	2.71 (1.63-4.46)**
- Use adhesives (n=277)	3.40 (1.38-9.29)*	1.90 (1.19-3.06)*	2.69 (1.80-4.04)**	3.40 (2.17-5.4)**	3.52 (2.14-5.96)**
- Use adhesive removing solvents (n=196)	2.73 (1.11-6.78)*	1.39 (0.84-2.27)	1.96 (1.30-2.95)**	2.29 (1.47-3.57)**	3.09 (1.89-5.07)**

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; NC: not calculable; WRSS: work-related skin symptoms
 Each OR represents a separate regression model adjusted for host-related factors (age, gender, atopy, family history of allergy to any substance, and personal domestic cleaning frequency ≥ 1 time / week). Reference group of comparison are those workers who reported that they were not using the chemical or were not performing the task.

Supplementary Table 11: Association between duration and frequency of occupational exposures and work-related skin outcomes in secondary adjusted logistic regression models

Adjusted odds ratio (95% Confidence Interval)					
	Probable contact urticaria (n=22)	Probable contact dermatitis (n=86)	WRSS ever (n=130)	WRSS in the last 12 months (Definition 1) (n=103)	WRSS in the last 12 months (Definition 2) (n=80)
<i>Duration of chemical agent exposure by work activity</i>					
Specimen preparation					
1-99 mins/week	4.18 (1.65-10.19)**	1.31 (0.72-2.30)	1.17 (0.69-1.93)	1.07 (0.59-1.86)	0.83 (0.41-1.56)
≥ 100 mins/week	NC	NC	1.24 (0.06-8.95)	1.65 (0.08-11.96)	NC
Patients' skin / wound cleaning and disinfection					
1-99 mins/week	2.76 (0.76-7.98)	1.44 (0.63-2.97)	1.12 (0.55-2.16)	1.39 (0.66-2.74)	1.93 (0.90-3.85)
≥ 100 mins/week	1.90 (0.10-10.60)	1.70 (0.47-4.84)	2.30 (0.88-5.71)	2.58 (0.94-6.52)	2.16 (0.68-5.83)
<i>Duration of job task exposure by work activity</i>					
Patients' skin / wound cleaning and disinfection					
1-99 mins/week	2.46 (0.63-8.33)	0.95 (0.47-1.80)	1.64 (0.98-2.72)	1.62 (0.91-2.80)	1.44 (0.76-2.64)
≥ 100 mins/week	6.18 (2.37-17.18)**	1.69 (0.97-2.89)	1.80 (1.10-2.90)*	2.06 (1.22-3.44)*	1.67 (0.91-2.96)
<i>Frequency of chemical exposure by work activity</i>					
Specimen preparation (days/week)	1.28 (1.04-1.54)*	1.03 (0.87-1.19)	1.06 (0.92-1.20)	1.05 (0.89-1.20)	0.94 (0.75-1.12)
Patients' skin / wound cleaning and disinfection (days/week)	1.35 (1.09-1.63)**	1.10 (0.94-1.26)	1.13 (1.00-1.27)*	1.16 (1.02-1.31)*	1.17 (1.02-1.34)*
<i>Frequency of job task exposure by work activity</i>					
Patients' skin / wound cleaning and disinfection					
- Days/week	1.38 (1.13-1.68)**	1.09 (0.97-1.21)	1.12 (1.02-1.23)**	1.14 (1.03-1.27)**	1.11 (0.99-1.24)
- Times/day	1.11 (1.04-1.19)**	1.03 (0.97-1.08)	1.03 (0.98-1.08)	1.04 (0.99-1.09)	1.02 (0.96-1.07)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; *: P -value < 0.05; **: P -value < 0.01

NC: not calculable; WRSS: work-related skin symptoms

Each OR represents a separate regression model adjusted for host-related factors (family history of allergy to any substance and personal domestic cleaning frequency ≥ 1 time / week). Reference group of comparison were those workers who reported that they were not using the chemical or were not performing the task.

Supplementary Table 12: Association between self-identification of chemicals causing work-related skin outcomes in secondary adjusted logistic regression models

	Probable contact urticaria (n=22)	Probable contact dermatitis (n=86)
<i>Chemical type</i>		
Ortho-phthalaldehyde (n=7)	15.51 (2.04-84.21)**	18.44 (3.84-131.79)**
Glutaraldehyde (n=5)	7.46 (0.36-57.31)	28.69 (4.10-570.04)**
Enzymatic cleaners (n=3)	15.06 (0.67-169.2)	NC
Chlorhexidine (n=54)	5.09 (1.71-13.67)**	7.96 (4.27-14.81)**
Quarternary ammonium compounds (n=4)	12.16 (0.57-107.32)	6.91 (0.81-58.86)
Bleach / chlorine-based products (n=17)	7.28 (1.57-25.19)**	6.60 (2.40-17.85)**
Ammoniated products (n=3)	NC	14.57 (1.35-320.93)*
Latex (n=19)	18.46 (5.84-54)**	5.58 (2.09-14.26)**
Liquid soap (n=11)	NC	2.61 (0.55-9.51)
All-purpose cleaner (n=4)	NC	2.54 (0.12-20.57)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; NC: not calculable; WRSS: work-related skin symptoms

Each OR represents a separate regression model adjusted for host-related factors (age, gender, atopy, family history of allergy to any substance, and personal domestic cleaning frequency ≥ 1 time / week). Reference group of comparison was those workers who did not identify the chemical as a cause of work-related skin outcomes.

Supplementary Table 13: Association between glove usage or training at work and skin outcomes in adjusted logistic regression models

	Probable contact urticaria (n=22)	Probable contact dermatitis (n=86)	WRSS ever (n=130)	WRSS in the last 12 months (Definition 1) (n=103)	WRSS in the last 12 months (Definition 2) (n=80)
Glove usage for medical instruments cleaning and disinfection (n=321)	1.41 (0.59-3.44)	0.97 (0.61-1.53)	1.27 (0.86-1.88)	1.11 (0.72-1.71)	1.20 (0.74-1.93)
- Manually disassemble instruments or remove gross contaminants (n=195)	1.49 (0.58-3.58)	1.10 (0.66-1.79)	1.23 (0.81-1.86)	1.14 (0.72-1.8)	1.15 (0.68-1.89)
- Prepare cleaning solutions (diluting or mixing) (n=232)	0.90 (0.34-2.18)	0.87 (0.53-1.40)	1.11 (0.73-1.65)	0.81 (0.50-1.26)	0.93 (0.56-1.52)
- Change sterilizing solutions (n=149)	0.80 (0.23-2.21)	0.73 (0.39-1.28)	0.98 (0.61-1.55)	0.68 (0.38-1.15)	0.61 (0.31-1.12)
- Manually sterilise or high-level disinfect (n=141)	3.64 (1.47-8.91)**	1.82 (1.08-3.03)*	1.85 (1.19-2.86)**	1.61 (0.99-2.58)	1.42 (0.82-2.40)
- Sterilise instruments with automated systems (n=13)	12.07 (2.46-46.85)**	4.91 (1.43-15.41)*	6.25 (2.02-21.25)**	8.26 (2.65-28.25)**	4.12 (1.19-12.98)*
Training on adverse health effects due to cleaning agents (218)	0.34 (0.08-1.03)	0.83 (0.49-1.36)	0.70 (0.44-1.09)	0.53 (0.31-0.88)*	0.57 (0.31-1.00)

Data are presented as OR (95% CI), unless otherwise indicated. OR: odds ratio; CI: confidence interval; *: P -value < 0.05; **: P -value < 0.01

NC: not calculable; WRSS: work-related skin symptoms

Each OR represents a separate regression model adjusted for host-related factors (family history of allergy to any substance and personal domestic cleaning frequency ≥ 1 time / week). Reference group of comparison were those workers who reported that they were not performing the task.

APPENDIX 2: ARTICLE – OCCUPATIONAL SKIN DISEASE IN HEALTH WORKERS, WITH A FOCUS ON CLEANING AGENTS – A REVIEW OF THE LITERATURE

Allergies in the workplace

OCCUPATIONAL SKIN DISEASE IN HEALTH WORKERS, WITH A FOCUS ON CLEANING AGENTS – A REVIEW OF THE LITERATURE

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ABSTRACT

Occupational skin disease is an important cause of morbidity in the global workforce; however, it is often under-diagnosed and under-reported. Health workers are a high-risk occupational group for work-related skin symptoms and conditions when compared to the general working population. Causative agents include both irritants and allergens. While most substances are potential irritants, important risk factors for occupational irritant contact dermatitis in health workers include wet working conditions and cleaning agent ingredients. These include disinfectants such as quaternary ammonium compounds present in surface cleaners and detergent foaming agents such as sodium lauryl sulphate in hand cleansers. With the substitution of less allergenic natural-rubber latex alternatives used in gloves over time, the incidence of latex allergy has declined. Common allergens associated with allergic contact dermatitis in health workers and occasionally implicated in Type-I immediate hypersensitivity reactions include cleaning agents (instrument disinfectants such as glutaraldehyde and ortho-phthalaldehyde, and hand hygiene disinfectants such as chlorhexidine) and glove-related rubber chemicals (especially thiuram). Preservatives and excipients in cleaning agents are also implicated in allergic contact dermatitis.

Keywords: occupational skin disease, occupational dermatoses, health workers, risk factors, cleaning agents, disinfectants, aldehydes, ortho-phthalaldehyde, glutaraldehyde, chlorhexidine, personal protective equipment, rubber accelerators

INTRODUCTION

As the second most common occupational disease after musculoskeletal disorders, occupational skin disease (OSD) is an important cause of morbidity in the general workforce.^{1,2} It is known to result in significant absenteeism and may impair individuals' quality of life (QoL) and prospects of sustaining or progressing their careers.^{3,4} In South Africa OSD is both under-reported and under-diagnosed.^{5,6} This is due to the lack of access to occupational health services and to decisions by workers not to report or treat minor symptoms, but also to occasional misdiagnoses.⁶ It is also under-compensated⁷ as a result of the hidden burden of the condition and significant delays in the compensation process in this country.

OSD includes a broad spectrum of skin conditions which may be induced or aggravated by the workplace, namely: irritant and allergic contact dermatitis (ACD), contact urticaria, nail disorders, leukoderma (loss of skin pigmentation), acne, infections and cancer.¹ According to Kanerva et al,¹ more than 95% of work-related dermatoses are sub-types of contact dermatitis.

The clinical manifestations and pathophysiology of contact dermatitis are reviewed in detail elsewhere.

Occupations in the healthcare sector are known to pose a high risk for OSD, particularly for occupational contact dermatitis (OCD).^{3,6-12} Natural-rubber latex as a high-risk allergenic agent is becoming less common due to greater awareness of potential latex allergy and the use of less allergenic alternatives or non-powdered low-protein latex gloves.³ Instead, wet work and cleaning agents are increasingly the focus of research on high-risk exposures for OSD.^{3,10} During outbreaks of disease such as COVID-19, health workers practise more intensive hand hygiene and surface disinfection, and use a wider range of personal protective equipment (PPE) more frequently and/or for prolonged periods.^{13,14} Increased health worker complaints of PPE-related OSD such as OCD, acne, contact urticaria, erosions and pressure effects have been reported during such outbreaks.^{13,15}

Prevention, early diagnosis and treatment of OSD have been

shown to improve outcomes.⁸ The occupational health and safety hierarchy of control measures should be applied in healthcare facilities as a framework to implement suitable prevention measures. The Cleaning and Disinfecting in Healthcare Working Group formed by the American National Institute for Occupational Safety and Health (NIOSH) and involving four countries, and the American National Occupational Research Agenda (NORA), provided international recommendations for an integrated and safe approach to environmental cleaning and disinfection in healthcare.¹⁵ Substituting safer alternatives must be considered when selecting products.¹⁶ Engineering controls such as adequate room size and ventilation must be available when using hazardous chemicals.¹⁶ Administrative control measures must include:

- regular health risk assessments;
- training in the safe use of products and PPE;
- communicating hazards to all stakeholders; and
- accurate labelling of products with appropriate safety warnings.¹⁶

Safety data sheets must be available for all chemical products used, listing all ingredients and relevant safety precautions. It should be remembered, however, that contaminants may be present in these products which would not be listed on the safety data sheet, and these may often vary within different batches.

Given the complex mixtures of cleaning agents used, PPE selection can be challenging.¹⁶ PPE selection must be based on the specific products and cleaning practices in use, as guided by the risk assessments and safety data sheets.¹⁶ Generally, handling high-level disinfectants such as glutaraldehyde or ortho-phthalaldehyde solutions requires the use of protective gloves (eg nitrile), impervious clothing (eg plastic apron or gown) and eye protection (eg goggles with side-shields).^{17,18} Wearing protective gloves is also advised when using surface disinfectants.

Screening (as part of medical surveillance¹⁷) may identify OSD at an early stage when there are relatively minor symptoms, and an intervention then is more likely to be successful in controlling the condition and the resultant impairment.

Internationally, research on OSD among health workers includes case reports, case series and epidemiological studies of the workforce. Locally available South African studies are case series and case reports (predominantly in tertiary healthcare and insurance or compensation industry settings), but no large-scale epidemiological studies for OSD in health workers have been published. Information gleaned from such studies of health workers in South Africa would provide a better understanding of the local prevalence of OSD in this occupational group, given the challenges of under-reporting and under-diagnosis – even though the studies would be limited to the 'healthy' workforce still in employment when only cross-sectional studies are performed. The analysis of the data collected in this way could also serve to assess the association with diverse cleaning agents in a South African context more reliably and explore the risk factors and the specific agents responsible for its development. This would help with implementing targeted prevention strategies and to lower the incidence of OSD in health workers.

The aim of this review is to examine the recent literature on OCD associated with multiple cleaning agents used by health workers in healthcare settings. The World Health Organization (WHO) defines health workers as 'all people engaged in actions whose primary intent is to enhance health'.¹⁹ This definition includes both health service-providers who directly deliver healthcare services and health management and support workers who are indirectly involved in healthcare.¹⁹ Aligned to this definition, the authors considered health workers as both clinical and non-clinical staff categories in the healthcare sector.

SEARCH STRATEGY

A literature search was conducted using the following databases: Pubmed, EbscoHost, Google Scholar, Science Direct and Scopus. Search terms were based on other similar reviews of the topic and included:

- OSD
- occupational dermatoses
- health workers
- risk factors
- cleaning agents
- disinfectants
- aldehydes
- ortho-phthalaldehyde (OPA)
- glutaraldehyde (GTA)
- chlorhexidine
- PPE
- rubber accelerators
- latex allergy.

Based on a pilot research project in South Africa and Tanzania, aldehydes, including OPA and GTA, and chlorhexidine were chosen because they were commonly used in the hospital setting. Latex allergy was included as it appeared frequently in the literature on occupational allergies in the healthcare sector. Relevant articles were also identified from the reference lists of articles obtained.

Articles were assessed for their relevance by title and abstract. The articles were also sorted by date (from the most recent) and were accepted if they had been published within the preceding ten years (ie 2010–2020). Full text articles were then reviewed by the study team and their inclusion was based on the completeness of the reported epidemiological study. Other inclusion criteria were:

- availability in English;
- emphasis on prevalence and risk factors for OSD in health workers;
- OSD in a South African context; and
- cutaneous effects of cleaning agent exposure in health workers.

Articles that looked at workplace-based studies were included, and population-based studies were excluded. Figure 1 is a flow diagram depicting the search strategy.

The authors acknowledge the limitation inherent in using articles that were available only in English, which creates the potential for selection bias.

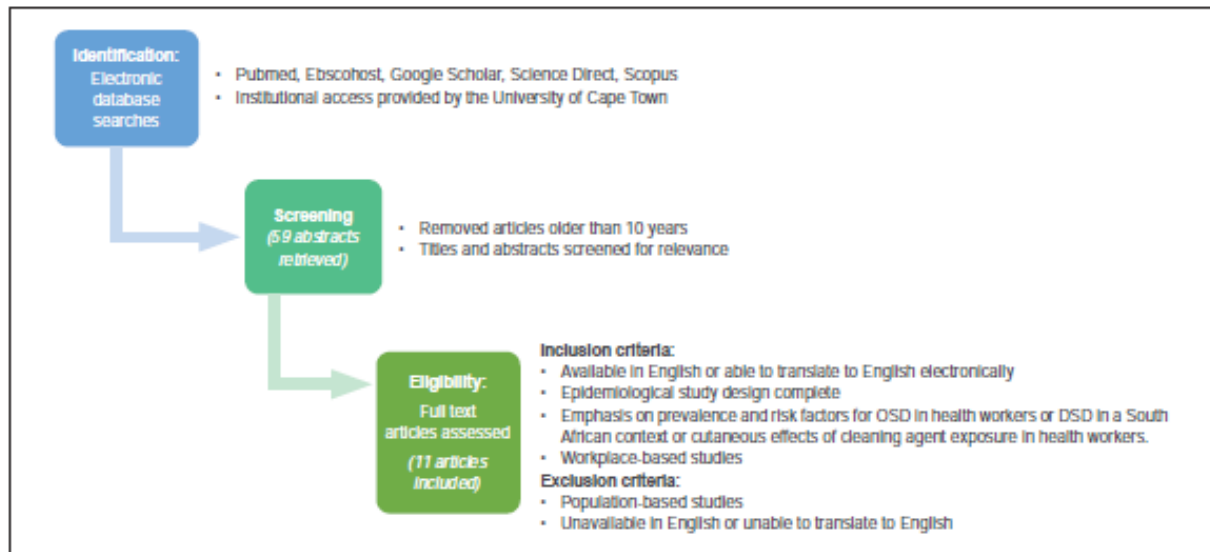


Figure 1: Flow diagram showing the search strategy

EPIDEMIOLOGY OF OSD ASSOCIATED WITH CLEANING AGENTS

There are few epidemiological studies of OSD in the general population and the data are therefore scarce. Most international data are based on epidemiological studies of defined subsets of occupational groups or on case series and case reports. Definitions of the occupational groups also vary between studies – for example, 'health workers' may include those with clinical roles only or all employees working in the healthcare setting. Therefore, drawing comparisons of occurrence of OSD between the general population and health workers is challenging. In addition, the challenges of under-reporting, under-diagnosis and the retention of healthier workers rather than diseased individuals may constitute sources of bias.

Some epidemiological studies of OSD in the general population are noteworthy. In a Swedish study by Meding,²⁰ a one-year prevalence of hand eczema in workers of 11% was found, with a point prevalence of 5.4%. In this study, cleaners had a higher one-year prevalence of hand eczema at 21.3%.²⁰

Smit et al²¹ conducted a series of surveys on various occupational groups and one on the general population of the Netherlands. Here they found an 8.2% one-year prevalence of hand dermatitis in the general population. For OSD, they found a 30% one-year prevalence of occupational hand dermatitis in the industry overall. For nurses it was slightly higher (31.6%).

A review of hand eczema in the general population by Thyssen et al²² found a 4% point prevalence of hand eczema, 10% one-year prevalence and a lifetime prevalence of approximately 15%.

The epidemiological studies focusing on health workers and skin disorder symptoms identified in the past decade are summarised in Table I. The range for the point prevalence of skin disorder symptoms in health workers globally was between 7% and 30.5% and that for the period prevalence was between 18.9%

and 76%. It is evident from the data that while these ranges are very wide, they reflect the potential for a high occurrence of OSD in health workers and cleaners.

In two South African-based case series at tertiary referral centres, health workers were found to be the most frequent occupational group with confirmed OSD reported by Burdzik and Todd (7/31, 23%),⁶ whereas health workers were the fourth commonest occupational group reported by Fourie and Carman (15/122, 12%).⁷ Similar case series in Brazil and Australia also found that health workers were a commonly affected occupational group.^{28,29} Local and international findings suggest that OSD, both irritant and allergic, was the commonest type of OSD seen.^{6,7,30,31}

OCCUPATIONS AT RISK

Within occupations in the healthcare sector, those workers performing clinical roles were more commonly affected than those in non-clinical roles.³¹ In Brunei Darussalam, Alhaji et al⁹ found a 16% point prevalence of skin disease symptoms in clinical staff and 7% in non-clinical staff ($p = 0.007$). The one-year prevalence was 24.3% in clinical staff and 11% in non-clinical staff ($p < 0.001$).⁹ Huzaifah and Titu Rahmawati¹⁰ found a one-year prevalence of OSD of 26.2% among clinical staff nurses in Malaysia; however, they noted only a 7.7% prevalence in a similar study in Saudi Arabia that recruited clinical and non-clinical staff nurses.³³ The occupations predominantly affected included nursing and nursing auxiliary staff, medical, dental and surgical staff, allied health staff, technologists and hospital cleaning staff.^{2,24,25}

WORKPLACE RISK FACTORS: CAUSATIVE AGENTS, JOB TASKS AND OCCUPATIONAL ENVIRONMENT

For occupational ICD, wet work was consistently reported as an important risk factor in health workers. Repeated exposure to wet work, along with other irritant exposures, leads to skin-barrier damage exceeding skin-barrier repair which results

TABLE I: EPIDEMIOLOGICAL STUDIES OF OSD IN HEALTHCARE IN THE PAST DECADE

AUTHOR/ YEAR	POPULATION (n)	PREVALENCE OF OSD PHENOTYPES/ SYMPTOMS	TASKS SIGNIFICANTLY ASSOCIATED WITH OSD OR/RR (95% CI) OR P-VALUE	CLEANING AGENTS SIGNIFICANTLY ASSOCIATED WITH OSD OR/RR (95% CI) OR P-VALUE	DIAGNOSTIC TOOLS USED
POINT PREVALENCE					
Nichol et al, 2019 ^a	Health workers in Canada (n = 508)	Hand dermatitis: 30.5%	Wet work ($p = 0.024$) (No OR reported)	Not specified	Hand Dermatitis Screening Tool (self- or OHNP-administered). Expert assessment of photographs.
Alhaji et al, 2018 ^b	Health workers in Brunet Darussalam (n = 400)	Skin disorder symptoms (SDS): 12%	Clinical role: 2.46 (1.26–4.79)	Contact with SDS-exacerbating materials (including latex gloves, handwashing, topical medicine, disinfectants): 3.73 (1.71–8.14)	Self-administered questionnaire
Gupta et al, 2018 ²⁴	Health workers in India (n = 710)	Hand eczema: 7.2%	Not specified	Common relevant agents: chlorhexidine, fragrance mix I, formaldehyde, mercaptobenzo- thiazole (No OR reported)	Self-administered questionnaire. Expert assessment. Patch testing, if eczema.
Schwensen et al, 2016 ²⁷	Health workers and non-health worker controls in Denmark (n = 2 804)	Recruited if contact dermatitis among health workers, OCD: 30.0%	Glove use (thiuram mix 1.60 (1.10–2.30)	MCIMI 0.66 (0.44–1.00), MI 0.58 (0.34–0.96)	National database for contact allergy (patch test information included)
Campion et al, 2014 ⁷¹	Health workers in the United Kingdom (n = 2 762)	Work-related skin symptoms: Clinical 20% Non-clinical 7%	Handwashing > 20 ×/day ($p < 0.01$) (No OR reported)	Not specified	Self-administered questionnaire
PERIOD PREVALENCE					
Barnes et al, 2019 ²⁶	Health workers, in Australia (n = 1 050) Clinical staff 91.3%; non- clinical staff 8.7%	One-year prevalence of symptoms related to chlorhexidine: Symptoms of sensitivity overall 23.8% Dry skin 23.0% Eczema 8% Local rash 9.5% Widespread rash 1.5%	Not specified	Chlorhexidine-based solutions ($p < 0.05$ for nurses and allied health staff) (No OR reported)	Self-administered questionnaire
Huzalfah & Titi Rahmawati, 2019 ¹⁰	Staff nurses in Malaysia (n = 206)	One-year prevalence of occupational hand contact dermatitis: 26.2%	Glove use ($p = 0.001$) and wearing gloves > 10 hours/week ($p = 0.037$) (No OR reported)	Hand wash liquid/soap ($p = 0.001$) (No OR reported)	Self-administered questionnaire
Alhaji et al, 2018 ^b	Health workers in Brunet Darussalam (n = 400)	Skin disorder symptoms (SDS): one-year prevalence 19%	Clinical role: At one year: 2.54 (1.46–4.43)	Contact with SDS-exacerbating materials (including: latex gloves, handwashing, topical medicine, disinfectants): At one year: 4.75 (2.41–9.37)	Self-administered questionnaire
Gupta et al, 2018 ²⁴	Health workers in India (n = 710)	Hand eczema: one-year prevalence 18.9%	Not specified	Common relevant antigens: chlorhexidine, fragrance mix I, formaldehyde, mercaptobenzo- thiazole (No OR reported)	Self-administered questionnaire. Expert assessment. Patch testing, if eczema.
Hamnerius et al, 2018 ⁶²	Clinical health workers in Sweden (n = 474)	History of hand eczema in last 12 months: 76% Of the above: OCD 62% ICD 89% ACD 8%	Not specified	Concomitant allergy with rubber additives in gloves: fragrances 6.3 (2.3–17.1) preservatives 7.1 (2.8–22.3)	Self-administered questionnaire. Patch testing.
Hamnerius et al, 2018 ²⁶	Clinical health workers in Sweden (n = 9051)	Hand eczema: one-year prevalence 21%	Wet work and time wearing gloves 1.60 (1.35–1.90)	Wet work and handwashing with soap at work 1.22 (1.07–1.38) Wet work and alcoholic hand disinfectant 1.27 (1.09–1.49)	Self-administered questionnaire

TABLE I: CONTINUED

AUTHOR/ YEAR	POPULATION (n)	PREVALENCE OF OSD PHENOTYPES/ SYMPTOMS	TASKS SIGNIFICANTLY ASSOCIATED WITH OSD OR/RR (95% CI) OR P-VALUE	CLEANING AGENTS SIGNIFICANTLY ASSOCIATED WITH OSD OR/RR (95% CI) OR P-VALUE	DIAGNOSTIC TOOLS USED
Mekonnen et al, 2018 ¹⁷	Clinical health workers in Ethiopia (n = 422)	OCD in past 12 months: 31.5% (redness 28.5%, burn 17.3%)	Glove-change frequency 3.22 (2.05–5.87) Handwashing frequency 1.80 (1.10–3.20)	Not specified	Interviewer-administered questionnaire
Ibler et al, 2016 ⁴⁴	Clinical health workers in Denmark (n = 120)	Recruited if self-reported hand eczema within one year. Delayed-type hypersensitivity: 53% Immediate-type hypersensitivity: latex allergy 2.5% chlorhexidine allergy < 1%	Not specified	Relevant agents on patch tests: thiuram 5%, fragrance mix I and II 8.3% and 3.3% respectively, MCI/MI 2%, formaldehyde 2%, lanolin alcohols 2% (No OR reported)	Patch tests. Prick tests and serology (IgE for latex, Chlorhexidine and ethylene oxide).
Callahan et al, 2013 ²³	Clinical health workers in the United States (n = 113)	Hand eczema developed at least once in 51.1% of health workers during the six months follow-up	Handwashing frequency (≥ 10 x/day) 1.55 (1.01–2.39)	Sodium lauryl sulphate 1.87 (1.06–3.31)	Irritant patch testing
PREVALENCE NOT SPECIFIED					
Ibler et al, 2012 ²⁷	Clinical health workers in Denmark (n = 2 269)	Not specified	Handwashing frequency (p < 0.001) Glove use and handling medication (p = 0.014), Phlebotomy (p = 0.019), Handling food articles (p = 0.004) (No OR reported)	Glove use and detergents (p = 0.035) (No OR reported)	Self-administered questionnaire

* Health Workers include clinical and non-clinical staff unless otherwise specified.

OSD – occupational skin disease; OR – odds ratio; RR – risk ratio; CI – confidence interval; ICD – Irritant contact dermatitis; ACD – allergic contact dermatitis; MCI – methylchloroisothiazolinone; MI – methylisothiazolinone

in ICD. Wet work includes frequent handwashing, performing activities where a large part of the working time is spent with the hands in a wet environment or moist hands due to wearing occlusive/waterproof gloves.³⁴ Important exposure considerations included:

- frequency of wet-dry cycles;
- number of glove changes per day;
- duration of time with wet hands or wearing waterproof gloves;
- ambient temperature;
- relative humidity; and
- hands sweating.^{34,35}

All substances have irritant potential – some are harsh irritants (ie corrosives), whereas others are mild irritants. Differences in concentration also affect irritant potential. Some examples are listed below:

- In a case series from Czechia, disinfectants (32%) and cleaning agents (12%) were the predominant substances registered as causative agents for ICD in health workers.³⁶
- Disinfectant quaternary ammonium compounds such as benzalkonium chloride have been reported frequently in the literature as known irritants associated with ICD but they may sometimes result in ACD.^{37,38}
- Povidone iodine is another chemical that has long been used as a disinfectant agent: current formulations in use for topical application are weakly irritant compared to other disinfectants and it rarely causes ACD.³⁸

- Repeated use of soap and/or detergent hand cleansers are also a risk factor for occupational ICD, more so than alcohol-based hand rubs.³⁴
- A cohort study by Callahan et al²³ found that sodium lauryl sulphate was an important irritant associated with hand eczema in health workers – this is a common detergent foaming agent found in cleaning and hygiene products, including hand cleansers.

Other relevant cleaning agents associated with skin-disorder symptoms in health workers and based on epidemiological studies are shown in Table I. Table II lists the common exposures in cleaning agents and related products that can cause OSD as illustrated in Figures 2a–c.

Upon sensitisation, occupational allergens may cause ACD (a Type-IV delayed hypersensitivity condition) or contact urticaria syndrome, including protein contact dermatitis (Type-I immediate hypersensitivity condition). Common culprit allergens identified on patch testing and associated with ACD in health workers include:

- glove-related rubber accelerator chemicals (thiurams more so than carbamates, benzothiazoles and guanidines);⁴⁰
- biocidal preservatives (formaldehyde, formaldehyde releasers, methylchloroisothiazolinone and methylisothiazolinone);⁴¹
- excipients (commonly coconut diethanolamide); and
- disinfectants (including chlorhexidine) in hand cleansers, surgical scrubs and alcohol-based hand rubs.^{3,26}



Figure 2a: Use of disinfectants for decontaminating medical instruments



Figure 2b: Preparation of disinfectant solutions



Figure 2c: Use of various surface cleaning agents

Natural-rubber latex is usually associated with Type-I immediate hypersensitivity reactions and is becoming less of a concern, as described earlier. The incidence of sensitisation to natural-rubber latex has decreased to 1% with the implementation of avoidance measures.⁴² More recently, Type-I immediate hypersensitivity and Type-IV delayed hypersensitivity have been reported following exposure to disinfectants such as aldehydes (eg glutaraldehyde⁴³ and ortho-phthalaldehyde (OPA)⁴⁴ used to disinfect medical instruments) and chlorhexidine gluconate used in hand-hygiene products and dental solutions.^{25,45} It is noted that hypersensitivity reactions upon exposure to these agents ranged from local to generalised skin reactions, respiratory or other systemic reactions and even anaphylaxis.^{38,44,46} Owing to concerns about glutaraldehyde toxicity, OPA and combinations of hydrogen peroxide and peracetic acid were introduced as safer high-level disinfectant options.⁴⁷ However, when Anderson et al⁴⁸ compared the irritant and allergy potential of glutaraldehyde and OPA induced by topical application, they found that OPA had more skin irritancy and allergenicity than glutaraldehyde. The agents causing Type-I hypersensitivity skin conditions are generally both dermal and respiratory sensitisers.^{43,44}

A lack of health and safety training on cleaning agents and hand hygiene together with the lack of safe-use protocols for high-level disinfectants which are used to eliminate most micro-organisms on medical instruments were found to be risk factors for OCD.¹² Mekonnen et al,¹² in their study of health workers in Ethiopia, found that a lack of health and safety training was associated with an increased risk of developing OCD (AOR 2.12 [95% CI 1.12, 2.25]). The implementation of an appropriate health and safety training programme is therefore an important protective measure for reducing the risk of OCD.

Control measures are also important in reducing exposure to occupational hazards. The study of Henn et al⁴⁹ on the precautionary practices and use of PPE of approximately 4 000 health workers in the United States using high-level disinfectants found that 44% did not wear water-resistant gowns, 9% did not wear protective gloves, 12% reported skin contact and 17% lacked safe-handling training.⁴⁹

Avoiding prolonged glove-wearing times and changing gloves frequently are also recommended: glove wearing > 10 hours/week ($p = 0.037$)¹⁰ or > 3 hours/day (OR 1.60 [95% CI 1.35, 1.90])

was associated with hand dermatitis;²⁴ wearing > 5 pairs gloves/day was associated with OCD (AOR 3.22 [95% CI 2.05, 5.87]).¹²

HOST-RELATED RISK FACTORS

The prevalence of ICD in health workers was found to be inversely proportional to age, with lower prevalence in older age groups.⁸ It is noted, however, that the study participants were possibly those who had been in the occupation for longer and would be less likely to have disease due to the 'healthy worker' effect (a type of selection bias due to people remaining in employment being healthier than those who are unemployed). There was generally a higher occurrence of ICD in women,⁹ but this is probably due to the gendered distribution of work. A personal history of atopy⁷ and of atopic dermatitis^{8,9,11} were also risk factors for ICD only. A history of allergy to any substance (including food, medication, metals and animal fur) was found to be a risk factor for OCD (ACD or ICD).^{10,12}

PREVENTION

The use of protective gloves to prevent skin contact when handling known irritant or allergenic substances and preventing dirty hands will reduce the need to wash hands frequently with soap and water.²⁴ Instead, alcohol-based hand disinfectants could be used when hands are not visibly soiled as they are less irritant than frequent handwashing and using detergents.^{34,50} The use of cotton gloves underneath rubber gloves may be considered to prevent the skin from becoming wet when prolonged glove-wearing times are required. If prolonged glove-wearing times and frequent glove changes are unavoidable, adopting skin-care measures is important. The use of moisturisers after handwashing as part of integrated skin care, including milder skin cleaning, is useful in maintaining skin barrier function and preventing OSD.^{11,34}

Safer glove alternatives should be considered, including powder-free low-protein latex gloves or preferably latex-free gloves, and rubber accelerator-free gloves – for example, nitrile accelerator-free, polychloroprene, polyisoprene or thermoplastic elastomer gloves.⁴⁰

In their analysis of various suppliers' natural-rubber latex gloves used in South Africa, Mabe et al⁵¹ found that none of the 14 types (powdered and non-powdered) met the criteria for low allergenicity with a total allergen content less than the suggested threshold limit (< 0.15 µg/g). Similarly, Ratshikhopa et al⁵² found

TABLE II: CLEANING AGENTS AND RELATED PRODUCTS ASSOCIATED WITH OSD IN HEALTH WORKERS

HIGH-LEVEL DISINFECTANTS	SURFACE DISINFECTANT CLEANERS	HAND CLEANERS/SURGICAL SCRUBS	CLEANING-ASSOCIATED AGENTS AND ACTIVITIES
Glutaraldehyde Ortho-phthalaldehyde (OPA) <i>Less commonly:</i> Hydrogen peroxide Peracetic acid	Quaternary ammonium compounds (including benzalkonium chloride) Ammonia/ammonium hydroxide Sodium hypochlorite	Disinfectants Chlorhexidine Povidone iodine Detergent foaming agents Sodium lauryl sulphate (SLS) <i>Less commonly:</i> Sodium laureth sulphate (SLES) Alkyl polyglucoside (APG) Excipients Coconut diethanolamide	Glove-related rubber components Accelerators (thiurams, dithiocarbamates, benzothiazoles, guanidines, thioureas) Dyes Hev b sensitising latex proteins Water (wet work)
	Preservatives Formaldehyde Formaldehyde releasers (including quaternium 15, dimethyloldimethyl [DMDM] hydantoin, imidazolidinyl urea [IMID], diazolidinyl urea, bronopol, parabens) Methylchlorisothiazolinone Methylisothiazolinone Additives Fragrance		

* Sources: References^{37,38,41,42}

that only four of the 20 (20%) natural-rubber latex glove types used in South Africa and analysed in their study were below this threshold. The quality and latex content of gloves are important criteria to consider in procurement processes for gloves and procurement officers should therefore be aware of locally available testing for the latex concentration and allergenicity of gloves to prevent OSD.⁵² However, there is no universal glove type which suits all requirements and glove choices should be based on multiple factors apart from allergenicity, including tasks and hazard exposure.

Other protective measures include the procurement of cleaning agents containing proven safer ingredients – for example, sodium laureth sulphate or alkyl polyglucoside instead of the harsher irritant sodium lauryl sulphate.⁵³ Medical surveillance of health workers in high-risk roles or performing high-risk tasks using cleaning agents, as a secondary prevention measure, is also recommended for early disease detection and the prevention of serious health outcomes.⁵⁴ Questionnaire interviews, physical examination and appropriate immunological testing are useful tools in the surveillance of these health workers.⁵⁴

CONCLUSION

Health workers remain a high-risk occupational group for OSD

despite the use of less allergenic alternatives for latex gloves. This is related to cleaning chemicals and cleaning activities such as hand hygiene, the use of protective gloves, surface cleaning and instrument disinfection. These are important considerations to include in occupational health and safety training for health workers so as to broaden knowledge and awareness in an effort to promote safe practices. It is also an important consideration in the safe selection and procurement of cleaning products and PPE such gloves.

Future studies should focus on the important research gaps identified so as to gain a better understanding of the local prevalence and risk factors. Such studies should include South African epidemiological studies on OSD associated with cleaning agents in health workers.

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DECLARATIONS OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

This article has been peer reviewed.

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APPENDIX 3: ETHICS APPROVAL



UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee



E-52 Room 45- Old Main Building
Grootte Schuur Hospital
Observatory 7925
Telephone [021] 406 6492
Email: hrec-enquiries@uct.ac.za

Website: www.health.uct.ac.za/fhs/research/humanethics/forms

15 December 2021

HREC REF: 811/2021

Prof M Jeebhay
Division of Occupational Medicine
Falmouth Building
Email: mohamed.jeebhay@uct.ac.za
Student: SNDZAH002@myuct.ac.za

Dear Prof Jeebhay

PROJECT TITLE: DETERMINANTS OF WORK-RELATED SKIN SYMPTOMS AND DERMATITIS ASSOCIATED WITH CLEANING AGENTS AMONG HEALTH WORKERS OF TWO TERTIARY HOSPITALS IN SOUTHERN AFRICA sub-study linked to 212/2013-MMED CANDIDATE0DR ZAHIDA SONDAY

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee (HREC) for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

This approval is subject to strict adherence to the HREC recommendations regarding research involving human participants during COVID -19, dated 17 March 2020; 06 July 2020 & 01 July 2021.

Approval is granted for one year until the 30 December 2022.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

The HREC acknowledge that the student: - Dr Zahida Sunday also be involved in this study

Please quote the HREC REF 811/2021 in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

HREC/REF 811/2021sa

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FACULTY OF HEALTH SCIENCES HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637.

Institutional Review Board (IRB) number: IRB00001938

NHREC-registration number: REC-210208-007

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use: Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2020), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI), and Declaration of Helsinki (2013) guidelines. The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

HREC/REF 811/2021sa

APPENDIX 4: CONSENT FORM

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: _____

Cell

9. E-mail address: _____

10. Interviewer's initials _____

21-22

11. Date of interview: Day _____ Month _____ Year _____

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2
3
-
2
8

12. Health facility: _____

29

13. Department / Section / Area: _____

30-31

14.1 Date of last shift? Day _____ Month _____ Year _____

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3
2
-
3
7

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
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1.2 Have you had wheezing or whistling in your chest at any time in the
last 12 months? ___ Yes (1)
___ No (2)

	45
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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

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)

If YES, state the condition

_____ 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)

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)

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

____ Yes (1)
 ____ No (2)

Asthma

1. Have you **ever** had attacks of breathlessness at rest with wheezing in your chest? ____ Yes (1)
 ____ No (2)

61

62

63

64

65

66

67

Section D: Appendices

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

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

71

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?

Enter approximate age: years old

O
R

Card 2
 1-2

Enter approximate year: Year

3-6

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

Enter approximate age:

O
R

_____ years old

Enter approximate year:

Year

7-8

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:

O
R

_____ years old

Enter approximate year:

Year

21-22

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:

O
R

_____ years old

28-29

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

Section D: Appendices

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 bronchodilators, 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 bronchodilators 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 inhaled steroids, 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 inhaled steroids 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 oral steroids, 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 oral steroids 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)

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

Card 3
 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:

Section D: Appendices

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:

O
R

_____ years old

6-7

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?

Section D: Appendices

Enter approximate age:
O
R
 Enter approximate year:

_____ years old

		27-28
--	--	-------

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	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<table border="1"> <tr><td style="width: 20px; height: 20px;"></td><td style="padding-left: 5px;">34</td></tr> <tr><td style="width: 20px; height: 20px;"></td><td style="padding-left: 5px;">35</td></tr> </table>		34		35
	34						
	35						
1.3.2. Hives (“bommels”)	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<table border="1"> <tr><td style="width: 20px; height: 20px;"></td><td style="padding-left: 5px;">36</td></tr> <tr><td style="width: 20px; height: 20px;"></td><td style="padding-left: 5px;">37</td></tr> </table>		36		37
	36						
	37						
1.3.3. Dry, scaly skin	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<table border="1"> <tr><td style="width: 20px; height: 20px;"></td><td style="padding-left: 5px;">38</td></tr> <tr><td style="width: 20px; height: 20px;"></td><td style="padding-left: 5px;">39</td></tr> </table>		38		39
	38						
	39						
1.3.4. redness of the skin	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<table border="1"> <tr><td style="width: 20px; height: 20px;"></td><td style="padding-left: 5px;">40</td></tr> <tr><td style="width: 20px; height: 20px;"></td><td style="padding-left: 5px;">41</td></tr> </table>		40		41
	40						
	41						
1.3.5. Blisters or weeping skin	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<table border="1"> <tr><td style="width: 20px; height: 20px;"></td><td style="padding-left: 5px;">42</td></tr> <tr><td style="width: 20px; height: 20px;"></td><td style="padding-left: 5px;">43</td></tr> </table>		42		43
	42						
	43						
1.3.6. Burning skin	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<table border="1"> <tr><td style="width: 20px; height: 20px;"></td><td style="padding-left: 5px;">44</td></tr> <tr><td style="width: 20px; height: 20px;"></td><td style="padding-left: 5px;">45</td></tr> </table>		44		45
	44						
	45						
1.3.7. Rash within an hour of contact with a rubber latex product	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<table border="1"> <tr><td style="width: 20px; height: 20px;"></td><td style="padding-left: 5px;">46</td></tr> <tr><td style="width: 20px; height: 20px;"></td><td style="padding-left: 5px;">47</td></tr> </table>		46		47
	46						
	47						

<p>1.3.8.</p> <p>Other, specify: _____</p> <p>_____</p> <p>_____</p>	<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ___ Yes (1) ___ No (2) </div>	<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ___ Yes (1) ___ No (2) </div>	<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	<p>48</p> <p>49</p> <p>50</p>
<p>1.4. Did you develop chest symptoms after experiencing these skin symptoms?</p> <p style="text-align: center;">___ Yes (1) ___ No (2)</p>			<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	<p>51</p>
<p>1.5. Are you using any medicines, including any creams or ointments, for your skin problems at present?</p> <p style="text-align: center;">___ Yes (1) ___ No (2)</p>			<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	<p>52</p>
If YES, go on to Question 1.5.1 If NO, skip to question 1.6				
<p>1.5.1. Which medicines?</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>			<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	<p>53</p> <p>54</p> <p>55</p>
<p>1.6. Have you ever bruised or injured your fingers or hands while working in the hospital?</p> <p style="text-align: center;">___ Yes (1) ___ No (2)</p>			<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	<p>56</p>
<p>1.7. How many times do you wash your hands in the course of a day?</p>			<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	<p>57-58</p>
Enter approximate number. ___ ___ times/day				
<p>1.8. Did you have eczema as a child?</p> <p style="text-align: center;">___ Yes (1) ___ No (2) ___ Don't know (3)</p>			<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	<p>59</p>
<p><u>Other allergic conditions</u></p>				
<p>1. Are you allergic to insect stings or bites?</p> <p style="text-align: center;">___ Yes (1) ___ No (2) ___ Don't know (3)</p>			<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	<p>60</p>

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

Section D: Appendices

<p>3.1.4. Breathlessness/tight chest/wheeze</p> <p style="text-align: right;">___ Yes (1) ___ No (2)</p>	<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	71
<p>3.1.5. Sneezing, itchy, stuffy or runny nose</p> <p style="text-align: right;">___ Yes (1) ___ No (2)</p>	<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	72
<p>3.1.6. Red, itchy or watery eyes</p> <p style="text-align: right;">___ Yes (1) ___ No (2)</p>	<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	73
<p>3.1.7. "Collapsed" / fainted</p> <p style="text-align: right;">___ Yes (1) ___ No (2)</p>	<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	74
<p>3.2. Have you ever being diagnosed with latex allergy?</p> <p style="text-align: right;">___ Yes (1) ___ No (2)</p>	<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	75
<p>If YES, go on to Question 3.2.1</p> <p>If NO, skip to question 4</p>		
<p>3.2.1. If Yes, when was it?</p> <div style="border: 1px solid #ccc; background-color: #f0f0f0; padding: 5px; margin-top: 10px;"> <p>Enter approximate age: _____ years old</p> <p style="text-align: center;">O R</p> <p>Enter approximate year: _____ Year</p> </div>	<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	<p>Card 4</p> <p>1-2</p>
<p>Enter approximate year: _____ Year</p>	<div style="border: 1px solid black; width: 40px; height: 20px; margin: 0 auto;"></div>	3-6
<p>4. Have you ever had an illness, health problem or allergy caused by eating a particular type of food /fruit?</p> <p style="text-align: right;">___ Yes (1) ___ No (2) ___ Don't know (3)</p>	<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	7
<p>If YES, go on to Question 4.1</p> <p>If NO, skip to question 5</p>		
<p>4.1 What type of food/fruit was this?</p> <p>_____</p>	<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	8-9
<p>4.1. Did this illness or health problem include:</p>		
<p>4.1.1 Itchy skin or rash</p> <p style="text-align: right;">___ Yes (1) ___ No (2)</p>	<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	10
<p>4.1.2 Diarrhoea or vomiting</p> <p style="text-align: right;">___ Yes (1) ___ No (2)</p>	<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	11
<p>4.1.3 Runny or stuffy nose</p> <p style="text-align: right;">___ Yes (1) ___ No (2)</p>	<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>	12

4.1.4 Severe headaches	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input style="width: 20px; height: 20px;" type="text"/> 13
4.1.5 Breathlessness/tight chest/wheeze	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input style="width: 20px; height: 20px;" type="text"/> 14
4.1.6 Other: _____		<input style="width: 20px; height: 20px;" type="text"/> 15
4.2 Was the food canned or preserved?	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input style="width: 20px; height: 20px;" type="text"/> 16
4.3 Do you experience these problems when you drink fizzy drinks also?	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input style="width: 20px; height: 20px;" type="text"/> 17
5. Have you ever had a surgical or dental operation that required you to be in theatre?	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input style="width: 20px; height: 20px;" type="text"/> 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?	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input style="width: 20px; height: 20px;" type="text"/> 19
6.2 Start to wheeze?	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input style="width: 20px; height: 20px;" type="text"/> 20
6.3 Get a tight chest?	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input style="width: 20px; height: 20px;" type="text"/> 21
6.4 Start to feel short of breath?	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input style="width: 20px; height: 20px;" type="text"/> 22
6.5 Get a runny/stuffy nose or sneeze?	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input style="width: 20px; height: 20px;" type="text"/> 23
6.6 Get itchy or watery eyes?	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input style="width: 20px; height: 20px;" type="text"/> 24
6.7 Get itchy skin/rash?	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2)	<input style="width: 20px; height: 20px;" type="text"/> 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)

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)

26

Type of allergy:	Parent	Sibling	Child
1.1 Hay fever	1	2	3
1.2 Eczema	1	2	3
1.3 Asthma	1	2	3
1.4 Food related (e.g. fruit, shellfish, spices)	1	2	3
1.5 Other allergy, Specify: _____	1	2	3

27-29

30-32

33-35

36-38

39-41

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:

O
R

Enter approximate year:

_____ years old

Year _____

43-44

45-48

1.2 Do you smoke at present?

'YES' means smoking tobacco in the last month or more

___ Yes (1) ___ No (2)

If YES, go on to Question 1.2.1

If NO, skip to Question 1.3

49

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)

If YES, go on to Question 1.3.1

If NO, skip to Question 1.4

55

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

Enter approximate age:

O
R

Enter approximate year:

_____ years old

Year _____

56-57

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

	— —	<table border="1" style="margin: auto;"> <tr><td style="width: 20px; height: 20px;"></td><td style="width: 20px; height: 20px;"></td></tr> </table>			
1.3.2.2 Pipe tobacco in grams/week	— — —	<table border="1" style="margin: auto;"> <tr><td style="width: 20px; height: 20px;"></td><td style="width: 20px; height: 20px;"></td><td style="width: 20px; height: 20px;"></td></tr> </table> 66-68			
1.4. Do you or did you inhale the smoke?	___ Yes (1) ___ No (2)	<table border="1" style="margin: auto;"> <tr><td style="width: 20px; height: 20px;"></td></tr> </table> 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)	<table border="1" style="margin: auto;"> <tr><td style="width: 20px; height: 20px;"></td></tr> </table> 70			
<i>'Regularly' means on most days or nights</i>					
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)	<table border="1" style="margin: auto;"> <tr><td style="width: 20px; height: 20px;"></td></tr> </table> 71			
If YES, go on to Question 1.1 If NO, skip to Question 2					
1.1. If Yes, what are these problems?		<table border="1" style="margin: auto;"> <tr><td style="width: 20px; height: 20px;"></td><td style="width: 20px; height: 20px;"></td></tr> </table> 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)	<table border="1" style="margin: auto;"> <tr><td style="width: 20px; height: 20px;"></td></tr> </table> 74			
If YES, go on to Question 2.1 If NO, skip to Question 3					
2.1. If Yes, what are these measures?		<table border="1" style="margin: auto;"> <tr><td style="width: 20px; height: 20px;"></td><td style="width: 20px; height: 20px;"></td></tr> </table> 75-76			
		<table border="1" style="margin: auto;"> <tr><td style="width: 20px; height: 20px;"></td><td style="width: 20px; height: 20px;"></td></tr> </table> 77-78			
3. Are there any protective measures currently in place in this hospital?	___ Yes (1) ___ No (2) ___ Don't know (3)	<table border="1" style="margin: auto;"> <tr><td style="width: 20px; height: 20px;"></td></tr> </table> 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?

- _____ 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)

	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?

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

	8
--	---

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

- _____ 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)

	9
--	---

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?

N e v e r	< 1 day /week	1-2 days /week	3-4 da ys / w e e k	5-7 day s / w e e k
(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 da y	1-2 days	3-4 days	5-7 day s
-------	----------------	-------------	-------------	-----------------

		/ week	/week	/ week	/ 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: _____
 O
 R
 Enter approximate year: _____

_____ years old

 30-31

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?

- _____ 3.1. Registered nurse
- _____ 3.2. Enrolled nurse
- _____ 3.3. Nurse assistant

 38-39

- _____ 3.4. Clean
- _____ er
- _____ 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
- _____ .
- _____ E
- _____ y
- _____ e
- _____ 7.
- _____ Surge
- _____ ry
- _____ 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

Months

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

___ hours per week

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)

'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**?

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)

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

Yes (1) No (2) Don't know (3)

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

Yes (1) No (2) Don't know (3)

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)

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

Yes (1) No (2) Don't know (3)

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

42-43

44-45

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46-47

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48

49-50

51-52

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53

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54

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55

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56

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57

___ Yes (1) ___ No (2) ___ Don't know (3)

9.4. Other, specify: _____

58

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/sanitizers 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

_____	_____	<table border="1"> <tr> <td></td> <td></td> <td>1-2</td> </tr> <tr> <td></td> <td></td> <td>3-4</td> </tr> </table>			1-2			3-4
			1-2					
		3-4						
_____	times/day							
_____	_____							
	times/day							

Cleaning / Sterilizing Medical Instruments

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, endoscopes, 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 **sterilize or high-level disinfect medical instruments?**

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
--	----

Section D: Appendices

11.1.6. Peracetic acid	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)	<input type="checkbox"/> 11
11.1.6. Acetic acid	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)	<input type="checkbox"/> 12
11.1.7. Hydrogen peroxide	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)	<input type="checkbox"/> 13
11.1.8. Surgislip®	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)	<input type="checkbox"/> 14
11.1.9. Surgistain®	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)	<input type="checkbox"/> 15
11.1.10. Alcohol, such as ethyl alcohol 96% (ethanol), isopropanol, methylated spirits, alcohol 50%, or 70%	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)	<input type="checkbox"/> 16
11.1.11. Bleach or chlorine, such as Domestos®, Medisure®, Biocide D®, or Clorox®	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)	<input type="checkbox"/> 17
11.1.12. Bicarbonate concentrate 8.4%	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)	<input type="checkbox"/> 18
11.1.13. Citric acid 50%	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)	<input type="checkbox"/> 19
11.1.14. Citrosteril	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)	<input type="checkbox"/> 20
11.1.15. Renalin 100	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)	<input type="checkbox"/> 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) _____

(ii) _____

		24-25
		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? _____		
11.2.1.2.	How many times per day do you perform this task? _____		
11.2.1.3.	What is the duration of this task? _____ (hours)		
11.2.1.4.	Glove s used?	Ye s (1)	No (2)

		29
		30-31
		32-33
		34

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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							
	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)							<input type="checkbox"/> 38
11.2.1.6.2.	Extractor fans in the ceiling							
	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)							<input type="checkbox"/> 39
11.2.1.6.3.	Fan pushing contaminated air away from worker/s							
	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)							<input type="checkbox"/> 40
11.2.1.6.4.	Natural ventilation (open doors/windows)							
	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)							<input type="checkbox"/> 41
<p>11.3. In the last 12 months, have you ever prepared cleaning solutions for e.g. by diluting or mixing cleaning products?</p> <p style="text-align: center;"> <input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3) </p>								<input type="checkbox"/> 42
<p>IF 'NO': GO TO QUESTION 11.4 IF 'YES': CONTINUE WITH QUESTION 11.3.1</p>								

Section D: Appendices

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					

Section D: Appendices

11.3.1.6.4.	<p style="text-align: right;">___ Yes (1) ___ No (2) ___ Don't know (3)</p> <p>Natural ventilation (open doors/windows)</p> <p style="text-align: right;">___ Yes (1) ___ No (2) ___ Don't know (3)</p>	<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> 54
		<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> 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		

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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 <input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)
11.4.1.6.2.	Extractor fans in the ceiling <input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)
11.4.1.6.3.	Fan pushing contaminated air away from worker/s <input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)
11.4.1.6.4.	Natural ventilation (open doors/windows) <input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)

66

67

68

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**?

Don't know (3) No (2)
 Yes (1)

70

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? _____				
11.5.1.2.	How many times per day do you perform this task? _____				
11.5.1.3.	What is the duration of this task? _____ (hours)				
11.5.1.4.	Glove s used?		Ye s (1)	No (2)	
11.5.1.4.1.	T y p e ?	Latex (1)	Nitrile (2)	Vi ny l (3)	Yello w dom estic (4)

71

72-73

74-75

76

77

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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?					
11.5.1.6.1.	Local exhaust ventilation with hood and duct	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)				Card 7 <input type="checkbox"/> 1
11.5.1.6.2.	Extractor fans in the ceiling	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)				<input type="checkbox"/> 2
11.5.1.6.3.	Fan pushing contaminated air away from worker/s	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)				<input type="checkbox"/> 3
11.5.1.6.4.	Natural ventilation (open doors/windows)	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)				<input type="checkbox"/> 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**?

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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)

Specify:

7
 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

11.6.3.1.	How many days per week do you perform this task? _____				
11.6.3.2.	How many times per day do you perform this task? _____				
11.6.3.3.	What is the duration of this task? _____ (hours)				
11.6.3.4.	Gloves used?			Yes (1)	No (2)
11.6.3.4.1.	Type?	Latex (1)	Nitrile (2)	Vinyl (3)	Yellow domestic (4)
11.6.3.5.	Respirator used?			Yes (1)	No (2)
11.6.3.5.1.	What type of a respirator?				
	Surgical mask				1
	Particulate respirator such as an N95				2

10
 11
 12-13
 14-15
 16
 17
 18
 19

Section D: Appendices

	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							
	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)						<input style="width: 20px; height: 20px;" type="text"/> 20	
11.6.3.6.2.	Extractor fans in the ceiling							
	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)						<input style="width: 20px; height: 20px;" type="text"/> 21	
11.6.3.6.3.	Fan pushing contaminated air away from worker/s							
	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)						<input style="width: 20px; height: 20px;" type="text"/> 22	
11.6.3.6.4.	Natural ventilation (open doors/windows)							
	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3)						<input style="width: 20px; height: 20px;" type="text"/> 23	
11.6.4. Operate other system: _____							<input style="width: 20px; height: 20px;" type="text"/> 24	
11.6.4.1.	How many days per week do you perform this task? _____						<input style="width: 20px; height: 20px;" type="text"/> 25	
11.6.4.2.	How many times per day do you perform this task? _____						<input style="width: 20px; height: 20px;" type="text"/> 26-27	
11.6.4.3.	What is the duration of this task? _____ (hours)						<input style="width: 20px; height: 20px;" type="text"/> 28-29	
11.6.4.4.	Gloves used?				Yes (1)	No (2)		<input style="width: 20px; height: 20px;" type="text"/> 30
11.6.4.4.1.	Type?	Latex (1)	Nitrile (2)	Vinyl (3)	Yellow domestic (4)		<input style="width: 20px; height: 20px;" type="text"/> 31	
11.6.4.5.	Respirator used?				Yes (1)	No (2)		<input style="width: 20px; height: 20px;" type="text"/> 32
11.6.4.5.1.	What type of a respirator?						<input style="width: 20px; height: 20px;" type="text"/> 33	

	Surgic al 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)	<input type="text"/> 34
11.6.4.6.2.	Extractor fans in the ceiling ___ Yes (1) ___ No (2) ___ Don't know (3)	<input type="text"/> 35
11.6.4.6.3.	Fan pushing contaminated air away from worker/s ___ Yes (1) ___ No (2) ___ Don't know (3)	<input type="text"/> 36
11.6.4.6.4.	Natural ventilation (open doors/windows) ___ Yes (1) ___ No (2) ___ Don't know (3)	<input type="text"/> 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

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___ Yes (1) ___ No (2) ___ Don't know (3)	<input type="checkbox"/> 48
12.1.11. Air freshener, such as Biocidol disinfectant (Ocean Cherry), air freshener without disinfectant, or DUX	<input type="checkbox"/> 49
12.1.12. Carpet shampoo	<input type="checkbox"/> 50
12.1.13. Furniture polish	<input type="checkbox"/> 51
12.1.14. M4 paste	<input type="checkbox"/> 52
12.1.15. Stainless steel cleaner	<input type="checkbox"/> 53
12.1.16. Sumasan	<input type="checkbox"/> 54
12.1.17. Terrazzo cleaner	<input type="checkbox"/> 55
12.1.18. Wall cleaner	<input type="checkbox"/> 56
12.1.19. Washing powder for cleaning floor mops	<input type="checkbox"/> 57
12.1.20. Do you use any other products for cleaning fixed surfaces, equipment, or instruments?	<input type="checkbox"/> 58
Yes (1) No (2))	
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. _____

2. _____

59-60

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

Section D: Appendices

	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3) <hr/>	<input type="text"/> 68
14.6. Polish wood furniture	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3) <hr/>	<input type="text"/> 69
14.7. Polish stainless steel surfaces	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3) <hr/>	<input type="text"/> 70
14.8. Spray deodorant/ disinfectant	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3) <hr/>	<input type="text"/> 71
14.9. Sweep floors	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3) <hr/>	<input type="text"/> 72
14.10. Hovering	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3) <hr/>	<input type="text"/> 73
14.11. Rug beating	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3) <hr/>	<input type="text"/> 74
14.12. Mop floors	<input type="checkbox"/> Yes (1) <input type="checkbox"/> No (2) <input type="checkbox"/> Don't know (3) <hr/>	<input type="text"/> 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*?

Yes (1)
 No (2)
 Don't
 know (3)

Card 8

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

Exposure to chemicals used for specimen preparation

16. Do you ever *prepare specimens* 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)

13

Don't
know (3)

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

Exposure to Aerosolized Medicines Used on Patients

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/	J o b T i t l e	Start	En d	How man y	Were you regul arly

Section D: Appendices

Section/ Area	(what did you do?)	date (year)	date (year)	hour s/day did you work ?	expo sed to vapo urs, gases , gases , dusts , or fume s?

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	Type	Job Title (what did	Start date	End date	How many hour s/day	Were you regul arly expo sed to vapo urs,

Section D: Appendices

work- place	you do?)	(year)	(y ea r)	did you work ?	gases , gases , dusts , or fume s?

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)	Tot al (ye ars)

Changing Jobs

4. Have you ever had to change or leave a job or position because it affected your breathing? This would include changing jobs or positions within the same workplace.

___ Yes (1) ___ No (2) ___ Don't know (3)

23

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
--	----

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Ortho-phthalaldehydes such as Cidex OPA®, Cidex OPA® C	$\frac{Y}{(1)}$ $\frac{N(2)}{)}$	49
Glutaraldehydes such as Cidex®	$\frac{Y}{(1)}$ $\frac{N(2)}{)}$	50
Enzymatic cleaners, such as Endozime®, Biozyme®	$\frac{Y}{(1)}$ $\frac{N(2)}{)}$	51
Chlorhexidine containing products such as Bioscrub, D-germ, Biotane in alcohol, or Sterisrub	$\frac{Y}{(1)}$ $\frac{N(2)}{)}$	52
Quaternary ammonium compounds such as MEDDIS®	$\frac{Y}{(1)}$ $\frac{N(2)}{)}$	53
Bleach or chlorine, such as Domestos®, Medisure®, Biocide D®, Clorox®	$\frac{Y}{(1)}$ $\frac{N(2)}{)}$	54
Ammonia, such as Handysan, Ammonia cleaner (cleaner all purpose)	$\frac{Y}{(1)}$ $\frac{N(2)}{)}$	55
Other cleaning products for sterilisation/high-level disinfection of medical instruments	$\frac{Y}{(1)}$ $\frac{N(2)}{)}$	56
Other cleaning products for cleaning fixed surfaces	$\frac{Y}{(1)}$ $\frac{N(2)}{)}$	57
Floor strippers or waxes	$\frac{Y}{(1)}$ $\frac{N(2)}{)}$	58
Other liquid hand soaps/sanitisers	$\frac{Y}{(1)}$ $\frac{N(2)}{)}$	59
Adhesives, glues, or removers of surgical dressings	$\frac{Y}{(1)}$ —	60

Section D: Appendices

	N(2)) __Y (1)	
Aerosolised medicines	N(2)) __Y (1)	61
Gases or vapour	N(2)) __Y (1)	62
Latex rubber products	N(2)) __Y (1)	63
Very cold or very hot temperatures	N(2)) __Y (1)	64
Dust, please specify (paper dust, etc.): _____	N(2)) __Y (1)	65
Other, please specify:	N(2))	66
a) _____		67
b) _____		68
c) _____		69
d) _____		70
<i>Thinking about the last 12 months:</i>		
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)	<input type="checkbox"/> 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		

- a) Stay the same _____
- b) Get better _____
- c) Get worse _____

72

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*

- a) Stay the same _____
- b) Get better _____
- c) Get worse _____

73

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
O
R

Enter approximate year: _____
Year

75-76

77-80

1.4.2. Where were you working at time of the first symptoms?

- ___ 1. Employed in the healthcare industry
- ___ 2. Employed outside of the healthcare industry
- ___ 3. Student, please specify: _____

Card 9
 1

2

Work-related nose & eye symptoms

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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

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,

___Y
(1)

___N(2
)

12

Biotane in alcohol, or Sterisrub

Quaternary ammonium compounds such as MEDDIS®

___Y
(1)

___N(2
)

13

Bleach or chlorine, such as Domestos®, Medisure®, Biocide D®, Clorox®

___Y
(1)

14

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	N(2)) —Y (1) —	
Ammonia, such as Handysan, Ammonia cleaner (cleaner all purpose)	N(2)) —Y (1) —	15
Other cleaning products for sterilisation/high-level disinfection of medical instruments	N(2)) —Y (1) —	16
Other cleaning products for cleaning fixed surfaces	N(2)) —Y (1) —	17
Floor strippers or waxes	N(2)) —Y (1) —	18
Other liquid hand soaps/sanitisers	N(2)) —Y (1) —	19
Adhesives, glues, or removers of surgical dressings	N(2)) —Y (1) —	20
Aerosolised medicines	N(2)) —Y (1) —	21
Gases or vapour	N(2)) —Y (1) —	22
Latex rubber products	N(2)) —Y (1) —	23
Very cold or very hot temperatures	N(2)) —Y (1) —	24
Dust, please specify (paper dust, etc.): _____	N(2)) —Y (1) —	25
Other, please specify:	N(2)) —Y (1) —	26

N(2
)

- a) _____
- b) _____
- c) _____
- d) _____

	27
	28
	29
	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*

- a) Stay the same _____
- b) Get better _____
- c) Get worse _____

	32
--	----

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*

- a) Stay the same _____
- b) Get better _____
- c) Get worse _____

	33
--	----

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:

O
R

_____ years old

35-36

Enter approximate year:

Year _____

37-40

2.4.2. Where were you working at time of the first symptoms?

- 1. Employed in the healthcare industry
- 2. Employed outside of the healthcare industry
- 3. Student, please specify: _____

41

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)

48

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	N(2)) — Y (1)	
Ortho-phthalaldehydes such as Cidex OPA®, Cidex OPA® C	N(2)) — Y (1)	49
Glutaraldehydes such as Cidex®	N(2)) — Y (1)	50
Enzymatic cleaners, such as Endozime®, Biozyme®	N(2)) — Y (1)	51
Chlorhexidine containing products such as Bioscrub, D-germ, Biotane in alcohol, or Sterisrub	N(2)) — Y (1)	52
Quaternary ammonium compounds such as MEDDIS®	N(2)) — Y (1)	53
Bleach or chlorine, such as Domestos®, Medisure®, Biocide D®, Clorox®	N(2)) — Y (1)	54
Ammonia, such as Handysan, Ammonia cleaner (cleaner all purpose)	N(2)) — Y (1)	55
Other cleaning products for sterilisation/high-level disinfection of medical instruments	N(2)) — Y (1)	56
Other cleaning products for cleaning fixed surfaces	N(2)) — Y (1)	57
Floor strippers or waxes	N(2)) — Y (1)	58
Other liquid hand soaps/sanitisers	N(2)) — Y (1)	59

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	$\frac{\text{---Y}}{(1)}$	
Adhesives, glues, or removers of surgical dressings	$\frac{\text{---N(2)}}{)}$	60
	$\frac{\text{---Y}}{(1)}$	
Aerosolised medicines	$\frac{\text{---N(2)}}{)}$	61
	$\frac{\text{---Y}}{(1)}$	
Gases or vapour	$\frac{\text{---N(2)}}{)}$	62
	$\frac{\text{---Y}}{(1)}$	
Latex rubber products	$\frac{\text{---N(2)}}{)}$	63
	$\frac{\text{---Y}}{(1)}$	
Very cold or very hot temperatures	$\frac{\text{---N(2)}}{)}$	64
	$\frac{\text{---Y}}{(1)}$	
Dust, please specify (paper dust, etc.): _____	$\frac{\text{---N(2)}}{)}$	65
	$\frac{\text{---Y}}{(1)}$	
Other, please specify:	$\frac{\text{---N(2)}}{)}$	66
a) _____		67
b) _____		68
c) _____		69
d) _____		70
<i>Thinking about the last 12 months:</i>		
3.3. In the last 12 months , have you experienced these symptoms while you were at work at any time?		
	$\frac{\text{--- Yes (1)}}{\text{--- No (2)}}$	<input type="checkbox"/> 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?		
<i>Give all options at once (3)</i>		

Insert a cross (X) next to one answer only

- a) Stay the same _____
- b) Get better _____
- c) Get worse _____

 72

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*

- a) Stay the same _____
- b) Get better _____
- c) Get worse _____

 73

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
O
R
Enter approximate year: _____
Year

 75-76

 77-80

3.4.2. Where were you working at time of the first symptoms?

- ____ 1. Employed in the healthcare industry
- ____ 2. Employed outside of the healthcare industry
- ____ 3. Student, please specify: _____

Card 10
 1

 2

THANK YOU FOR ANSWERING THE QUESTIONNAIRE

APPENDIX 6: AUTHOR GUIDELINES FOR CHOSEN JOURNAL (CONTACT DERMATITIS)

Author Guidelines

Sections

1. Submission
2. Aims and Scope
3. Manuscript Categories and Requirements
4. Preparing the Submission
5. Editorial Policies and Ethical Considerations
6. Author Licensing
7. Publication Process After Acceptance
8. Post Publication
9. Editorial Office Contact Details

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2. AIMS AND SCOPE

Contact Dermatitis

is designed primarily as a journal for clinicians who are interested in various aspects of environmental dermatitis. This includes both allergic and irritant (toxic) types of contact dermatitis, occupational (industrial) dermatitis and consumers' dermatitis from such products as cosmetics and toiletries. The journal aims at promoting and maintaining communication among dermatologists, industrial physicians, allergists and clinical immunologists, as well as chemists and research workers involved in industry and the production of consumer goods. Papers are invited on clinical observations, diagnosis and methods of investigation of patients, therapeutic measures, organisation and legislation relating to the control of occupational and consumers' contact dermatitis, preventive measures and educational advice.

Papers concerned with the immunology of allergic contact dermatitis are invited for the purpose of bringing to the notice of the clinician, knowledge of important recent advances in the understanding of its theoretical basis, as well as papers on the physiology and pathology of the horny layer and epidermis in relation to its disturbance in the genesis of irritant dermatitis. A major section is devoted to Short Communications for the presentation of information on new contact allergens or other substances. An important objective of the Editor and Publisher is the rapid processing of submitted manuscripts, so that an early decision can be made on their acceptance, and final publication can be expedited by a short printing time.

3. MANUSCRIPT CATEGORIES AND REQUIREMENTS

i. Original Article

Word limit: A maximum of 8 printed pages (approx. 700 words per printed page) should normally not be exceeded.

Abstract: 200 words maximum; must be structured, under the sub-headings: Background, Objectives, Patients/Materials/Methods (as appropriate), Results, Conclusions.

ii. Review

Word limit: A maximum of 8 printed pages (approx. 700 words per printed page) should normally not be exceeded.

Abstract: 200 words maximum; not structured.

Systematic reviews and meta-analyses must be accompanied by a completed [PRISMA](#) or [MOOSE](#) checklist

iii. Contact Point

Word limit: 600 words maximum, including references. 400 words with a table or figure included may be accepted for publication if they serve to promote communication between clinicians and research workers.

Abstract: No abstract.

References: Ten references should normally not be exceeded.

Figures/Tables: Total of no more than 1 to 2 figures and tables. Note that as with other publication categories, additional tables, figures and text may be submitted as “Online supplemental material”.

Main Text structure: Case Report or Methods/Materials and Results, Discussion, as appropriate. In contrast to Original Articles, Reviews etc., contributions to this section will not undergo peer review but will be assessed by the editorial team.

Detailed information on preparing case reports as 'Contact Points' is found [in this guideline](#). The [Case Report checklist](#) intends to support authors in preparing their manuscript.

iv. Letter to the Editor

Word limit: Letters should normally not exceed 2 printed pages.

Abstract: No abstract.

References: Maximum of 10 references.

Figures/Tables: Total of no more than 1 figure or table.

This category is intended mainly for comments of existing publications and brief observations. Authors should decide whether a “Contact Point” may be a more appropriate format.

4. PREPARING THE SUBMISSION

What to consider when writing your main text, particularly on an Original Article

1. Introduction - Present the background briefly, but do not review the subject extensively. Give only pertinent, current (if possible) references. State the specific questions you want to answer.

2. Patients, Methods/Materials or Methods - Describe selection of patients or experimental animals, including controls. Do not use patients' names or hospital numbers.

- Identify patch test materials (supplier, dilution, vehicle), chambers used, application period and days of readings (use D2, D4 not 48, 96hrs etc).

- Identify methods, apparatus (manufacturer's name and address; for US companies, please include spelled-out state, but do not add "U.S.A.") and procedures in sufficient detail to allow other workers to reproduce the results. Provide references and brief descriptions of methods that have been published. When using new methods, evaluate their advantages and limitations.

- Identify drugs, chemicals and consumer products (including cosmetics unless a specific reason for non-disclosure is given) including generic name, dosage and route(s) of administration. Do not use 'trademark' and 'registered' symbols.

- Indicate whether the procedures were approved by a properly constituted Ethics Committee in your country, or in accordance with the current Helsinki Declaration. Drug trials must be logged on public register, the register and the registration number must be stated in the text.

3. Results - Present results in logical sequence in tables and illustrations. In the text, explain, emphasise or summarise the most important observations. When appropriate, data should be statistically evaluated and the appropriateness of the statistical methodology explained. Estimates (proportions, means, risk quotients etc.) should include confidence intervals. Authors are encouraged to seek advice from a statistician.

4. Discussion - Do not repeat in detail data given in the Results section. Emphasise the new and important aspects of the study. Relate the observations to other relevant studies. On the basis of your findings (and those of others), discuss possible implications/conclusions. Limitations, as well as strengths, of your study should be discussed, however, avoiding sweeping generalisations. When stating a new hypothesis, clearly identify it as such.

Cover Letters

Cover letters are not mandatory; however, they may be supplied at the author's discretion.

Free format submission

Contact Dermatitis now offers [Free Format submission](#) for a simplified and streamlined submission process.

However, the content of your manuscript must conform to the guidelines described in the Article Types. This is particularly important for Contact Points.

Before you submit, you will need:

- Your manuscript: this should be an editable file including text, figures, and tables, or separate files—whichever you prefer.
 - Figures and tables should have legends. Figures should be uploaded in the highest resolution possible.
 - References may be submitted in any style or format, as long as it is consistent throughout the manuscript.
 - Supporting information should be submitted in separate files.
 - If the manuscript, figures or tables are difficult for you to read, they will also be difficult for the editors and reviewers, and the editorial office will send it back to you for revision. Your manuscript may also be sent back to you for revision if the quality of English language is poor.
- An ORCID ID, freely available at <https://orcid.org>.
- *(Why is this important? Your article, if accepted and published, will be attached to your ORCID profile. Institutions and funders are increasingly requiring authors to have ORCID IDs.)*

- The title page of the manuscript, including:
 - Your co-author details, including affiliation and email address. (*Why is this important? We need to keep all co-authors informed of the outcome of the peer review process.*)
 - **If your article includes original research:** An ethical statement which should include any necessary ethical approval(s) and consent procedures.
 - **If your article includes images of people:** A statement that you obtained informed written consent from patients for these images to be included

Manuscripts can be uploaded either as a single document (containing the main text, tables and figures), or with figures and tables provided as separate files. The main manuscript file can be submitted in Microsoft Word (.doc or .docx) format.

To submit, login at <https://mc.manuscriptcentral.com/cod> and create a new submission. Follow the submission steps as required and submit the manuscript.

Submission of revisions

If you are invited to revise your manuscript after peer review, the journal will request the revised manuscript to be formatted according to journal requirements as described below.

Your revised manuscript should normally be submitted within 6 weeks. It is mandatory that all changes to the original manuscript (deletions, insertions, corrections) are highlighted, e.g. by using the 'track changes' function of the word processor. A separate point-by-point reply to reviewers' comments is encouraged, but not a substitute for above. Re-submissions not complying with this requirement will be immediately returned to you.

Please include a Graphical Abstract as part of your revised submission. Please see instructions below.

File Types

Manuscripts must be submitted as Word (DOC[X]) or LaTeX (TEX+BIB) files, and figures submitted as high resolution JPEG or PNG files, or as vector graphic PDFs. Do not embed figures within the main text; append them as separate files.

Parts of the Manuscript

The manuscript should be submitted in separate (doc, docx, tex+bib) files: main text file; figures.

Main Text File

The text file should be presented in the following order (please note that supplying this information only in the Scholar One metadata is not sufficient; the items listed below must be included in the actual manuscript text):

- i. A short informative title that contains the major key words. The title should not contain abbreviations (see Wiley's [best practice SEO tips](#));
- ii. The full names of the authors;
- iii. The author's institutional affiliations where the work was conducted, with a footnote for the author's present address if different from where the work was conducted;
- iv. Acknowledgments;

- v. Abstract and keywords;
- vi. Main text;
- vii. References;
- viii. Tables (each table complete with title and footnotes);
- ix. Figure legends;
- x. Appendices (if relevant, e.g. online supplemental information).

Figures and supporting information should be supplied as separate files.

Authorship

Please refer to the journal's authorship policy the **Editorial Policies and Ethical Considerations** section for details on eligibility for author listing.

Author Contributions: For all articles, the journal mandates the CRediT (Contribution Roles Taxonomy), for more information please see [Author Services](#).

Acknowledgments

Contributions from anyone who does not meet the criteria for authorship should be listed, with permission from the contributor, in an Acknowledgments section.

If the authors submit in the name of a research group, whose further members have contributed data, these can be separately acknowledged as "collaborators", both in the manuscript and in the metadata entered in Scholar One. "Collaborators" information should be the same as for authors, ie., include first and family name (the latter NOT underlined here), Institution, City, Country. Please note that the name of the group should, in this case, appear after the authors, and, identically, in the header of the acknowledgement footnote. In addition to collaborator names, their institution and address should be entered, as with authors proper. This enables transfer of the set of collaborators in Medline, where they can be retrieved. Financial and material support should also be mentioned. Thanks to anonymous reviewers are not appropriate.

Conflict of Interest Statement

Authors will be asked to provide a conflict of interest statement during the submission process. For details on what to include in this section, see the section 'Conflict of Interest' in the Editorial Policies and Ethical Considerations section below. Submitting authors should ensure they liaise with all co-authors to confirm agreement with the final statement.

Abstract

In addition to the abstract (see above for requirements related to different publication categories), please provide 3-8 keywords. Keywords should be taken from those listed in the Scholar One submission system, supplemented with appropriate terms, e.g. including CAS numbers.

Patient Photo Permissions

If photographs are recognizable, the authors must attest that they have obtained written consent for permission to publish.

References

All references should be numbered consecutively in order of appearance. In text citations should cite references in consecutive order using Arabic superscript numerals.

For more information about this reference style, please see the [AMA Manual of Style](#).

Reference examples follow; list up to 6 authors, while, if more than 6, list the first 3 followed by "et al".

Journal article

1. Malmberg P, Guttenberg T, Ericson MB, Hagvall L. Imaging mass spectrometry for novel insights into contact allergy - a proof-of-concept study on nickel. *Contact Dermatitis*. 2018;78(2):109-116.

Book

2. Voet D, Voet JG. *Biochemistry*. New York: John Wiley & Sons; 1990. 1223 p.

Please note that journal title abbreviations should conform to the practices of Chemical Abstracts.

Internet Document

3. American Cancer Society. Cancer Facts & Figures 2003. <http://www.cancer.org/downloads/STT/CAFF2003PWSecured.pdf>. Accessed March 3, 2003.

If using tools for reference management and formatting, we recommend the JAMA or JAMA dermatology output style as a good match for Contact Dermatitis

Tables

Tables should be self-contained and complement, not duplicate, information contained in the text. They should be supplied as editable files, or be included in the main text, not pasted as images. Legends should be concise but comprehensive – the table, legend, and footnotes must be understandable without reference to the text. All abbreviations must be defined in footnotes. Footnote symbols: †, ‡, §, ¶, should be used (in that order) and *, **, *** should be reserved for *P*-values. Statistical measures such as SD or SEM should be identified in the headings.

Figure Legends

Legends should be concise but comprehensive – the figure and its legend must be understandable without reference to the text. Include definitions of any symbols used and define/explain all abbreviations and units of measurement.

Figures (illustrations, chemical structures and photographs)

Should clarify the text and their numbers be kept to a minimum. Although authors are encouraged to send the highest-quality figures possible, for peer-review purposes, a wide variety of formats, sizes, and resolutions are accepted.

[Click here](#) for the basic figure requirements for figures submitted with manuscripts for initial peer review, as well as the more detailed post-acceptance figure requirements.

Colour Figures. Figures submitted in colour may be reproduced in colour free of charge. Please note, however, that it is preferable that line figures (e.g. graphs and charts) are supplied in black and white or grey-scales so that they are legible if printed in black and white.

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Additional Files

Appendices

Appendices which shall appear as part of the actual publication (i.e., not as online-only 'supporting information', see below) will be published after the references. For submission they should be supplied as separate files but referred to in the text.

Graphical Table of Content/Abstract

The journal's table of contents/abstract will be presented in graphical form with a brief abstract.

The table of contents entry must include the article title, the authors' names (with the corresponding author indicated by an asterisk), no more than 80 words or 3 sentences of text summarizing the key findings presented in the paper and a figure that best represents the scope of the paper. Table of contents entries should be submitted to ScholarOne as 'Supplementary material for review' during the initial manuscript submission process. The image supplied should fit within the dimensions of 50mm x60mm and be fully legible at this size.

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The following points provide general advice on formatting and style.

Abbreviations:

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Units of measurement:

Measurements should be given in SI or SI-derived units. Visit the Bureau International des Poids et Mesures (BIPM) website for more information about SI units.

Numbers:

numbers under 10 are spelt out, except for: measurements with a unit (8mmol/L); age (6weeks old), or lists with other numbers (11 dogs, 9 cats, 4 gerbils). Do not use Roman numerals in the text, except where established (e.g., “fragrance mix II”).

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Chemical names and botanical extracts

should be INCI, if available (<http://ec.europa.eu/consumers/cosmetics/cosing/>), and in preference to other common names; CAS numbers should be provided, if appropriate (e.g., 2-bromo-2-nitropropane-1,3-diol [bronopol; CAS no. 52-51-7]). For drugs, the International Non-proprietary Name (INN) should be used. (<http://www.who.int/medicines/services/inn/en/>).

Chemical structures

should be produced with a chemical structure drawing program (e.g., ChemSketch) and conform to the American Chemical Society settings.

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The journal supports the [Resource Identification Initiative](#), which aims to promote research resource identification, discovery, and reuse. This initiative, led by the [Neuroscience Information Framework](#) and the [Oregon Health & Science University Library](#), provides unique identifiers for antibodies, model organisms, cell lines, and tools including software and databases. These IDs, called Research Resource Identifiers (RRIDs), are machine-readable and can be used to search for all papers where a particular resource was used and to increase access to critical data to help researchers identify suitable reagents and tools.

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Additionally, authors must include the RRIDs in the list of keywords associated with the manuscript.

To Obtain Research Resource Identifiers (RRIDs)

1. Use the Resource Identification Portal, created by the Resource Identification Initiative Working Group.
2. Search for the research resource (please see the section titled “Search Features and Tips” for more information).
3. Click on the “Cite This” button to obtain the citation and insert the citation into the manuscript text.

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If any difficulties in obtaining identifiers arise, please contact rii-help@scicrunch.org for assistance.

Example Citations

Antibodies: "Wnt3 was localized using a rabbit polyclonal antibody C64F2 against Wnt3 (Cell SignalingTechnology, Cat# 2721S, RRID: AB_2215411)"

Model Organisms: "Experiments were conducted in c. elegans strain SP304 (RRID:CGC_SP304)"

Cell lines: "Experiments were conducted in PC12 CLS cells (CLS Cat# 500311/p701_PC-12,RRID:CVCL_0481)"

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Patient anonymity should be preserved. When detailed descriptions, photographs, or videos of faces or identifiable body parts are used that may allow identification, authors should obtain the individual's free prior informed consent. Authors do not need to provide a copy of the consent form to the publisher; however, in signing the author license to publish, authors are required to confirm that consent has been obtained. Wiley has a [standard patient consent form](#) available for use. Where photographs are used they need to be cropped sufficiently to prevent human subjects being recognized; black eye bars should not be used as they do not sufficiently protect an individual's identity; they are not a substitute for above-mentioned consent).

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A statement indicating that the protocol and procedures employed were ethically reviewed and approved, as well as the name of the body giving approval, must be included in the Methods section of the manuscript. Authors are encouraged to adhere to animal research reporting standards, for example the [ARRIVE guidelines](#) for reporting study design and statistical analysis; experimental procedures; experimental animals and housing and husbandry. Authors should also state whether experiments were performed in accordance with relevant institutional and national guidelines for the care and use of laboratory animals:

- US authors should cite compliance with the [US National Research Council's Guide for the Care and Use of Laboratory Animals](#), the [US Public Health Service's Policy on Humane Care and Use of Laboratory Animals](#), and [Guide for the Care and Use of Laboratory Animals](#).
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Research Reporting Guidelines

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- **Systematic reviews:** [PRISMA](#) or [MOOSE](#)
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- **Qualitative research:** [SRQR](#)
- **Diagnostic / prognostic studies:** [STARD](#)
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We also encourage authors to refer to and follow guidelines from:

- [Future of Research Communications and e-Scholarship \(FORCE11\)](#)
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Upon its first use in the title, abstract, and text, the common name of a species should be followed by the scientific name (genus, species, and authority) in parentheses. For well-known species, however, scientific names may be omitted from article titles. If no common name exists in English, only the scientific name should be used.

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Sequence variants should be described in the text and tables using both DNA and protein designations whenever appropriate. Sequence variant nomenclature must follow the current HGVS guidelines; see varnomen.hgvs.org, where examples of acceptable nomenclature are provided.

Sequence Data

Nucleotide sequence data can be submitted in electronic form to any of the three major collaborative databases: DDBJ, EMBL, or GenBank. It is only necessary to submit to one database as data are exchanged between DDBJ, EMBL, and GenBank on a daily basis. The suggested wording for referring to accession-number information is: 'These sequence data have been submitted to the DDBJ/EMBL/GenBank databases under accession number U12345'. Addresses are as follows:

- DNA Data Bank of Japan (DDBJ): www.ddbj.nig.ac.jp
- EMBL Nucleotide Archive: ebi.ac.uk/ena
- GenBank: www.ncbi.nlm.nih.gov/genbank

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- The corresponding author and co-authors can nominate up to ten colleagues to receive a publication alert and free online access to the article.

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