Describing the Categories of People that Contribute to an Emergency Centre Crowd at Khayelitsha Hospital, Western Cape, South Africa

By Dr. Emmanuel Kwadzo Ahiable

Masters of Science (Med) in Emergency Medicine Faculty of Health Sciences

University of Cape Town AHBEMM001

University of Cape Town

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Supervisor(s):

Dr. Stevan Raynier Bruijns (University of Cape Town)

Dr. Sa'ad Lahri (Khayelitsha Hospital)

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Dedication

For my wife Brenda and my wonderful children Richyda, Jason and Loretta in appreciation of their patience, love and understanding. Without them this would not have been possible.

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God accomplishes all things but He functions through people. It is in this light that I express my deepest gratitude to all those who through one way or other have contributed to my academic development in South Africa and beyond. It has been a long journey.

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To God be the glory!

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Abstract

Background: The emergency centre (EC) is a vibrant and challenging environment from both an operational and clinical perspective. Emergency centre crowding has been referred to as one of the biggest challenges confronting policy-makers, emergency healthcare professionals (including physicians and nursing staff) and their patients globally. Elsewhere, EC crowding has been thoroughly studied. Resource restrictions render more detailed flow studies less achievable locally. Anecdotally, our local ECs are perceived to be fairly crowded. This study aimed to describe the EC crowd at Khayelitsha hospital by establishing the number and different categories of people at predefined times during the day over a four week period.

Method: A prospective, cross-sectional, design was used. Headcounts were made by predefined groups at 09:00, 14:00 and 21:00 every day for four weeks. Predefined groups included doctors, nurses, visitors, patients, and other allied health staff. Summary statistics were used to describe the data and precision were described using the 95% confidence interval.

Results: There were 37, 34 and 27 different people categories found in the EC during the three different shifts respectively. A total of 16353 people were counted during the study period. On average 6370 (39%) of the groups were staff, 5231 (32%) were patients and 4752 (29%) were visitors. Of the staff, 1488 (9%) were EC nurses, 733 (4.4%) were non-EC doctors, 586 (3.6%) were EC doctors, and 445 (3%) were non-EC nurses. The EC was consistently crowded – average occupancy: 130%. Notably, Mondays had the highest occupancy of 144% and Sundays had the lowest of 130%.

Conclusion: Describing the people categories that contribute to the EC crowd in a low-to-middle income setting may provide a uniform template in defining EC crowding. In our study, we can conclude that the main findings were: Staff levels fluctuated predictably with less staff at night and over weekends whilst patients remained constant. Non-EC doctors more than doubled during the day on week shifts, in significantly more numbers than EC doctors, suggesting that many of the patients in the EC were likely to be admissions without a place to be admitted to. Although clinical staff numbers did not reduce during the busiest visitor times (afternoons), given the huge amount of crowding at this time care was likely to suffer. Further research is recommended to describe the findings in more detail including some of the limitations mentioned in this thesis.

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List of abbreviations

A&E, Accident, and Emergency

ACEM, Australasian College for Emergency Medicine

ACEP, American College of Emergency Physicians

CHC, Community health centre

CI, Confidence Interval

CT, Computerized tomography

CSSD, Central Sterile Services Department

EC, Emergency Centre

ECG, Electrocardiogram

ED, Emergency Department

EDCS, Emergency Department Crowding Scale

EDWIN, Emergency Department Work Index

EM, Emergency Medicine

EMSSA, Emergency Medicine Society of South Africa

EP, Emergency Physician

HIV, Human Immune-Deficiency Virus

HREC, Human Research Ethics Committee

ICU, Intensive care unit

IOM, Institute of Medicine

LMICs, Low-and Middle Income Countries

NEDOCS, National Emergency Department Overcrowding Scale

O&G, Obstetrics, and Gynaecology

READI, Real-time Emergency Analysis of Demand Indicators

REF, Reference

ROC, Receiver Operator Characteristic

TBH, Tygerberg hospital

UCT, University of Cape Town

USA, United States of America

USB, Universal Serial Bus

WHO, World Health Organisation

Chapter 1: Introduction

1.1 Background

The Emergency Centre (EC) is a complex clinical setting with unpredictable workflow and at times a propensity for crowding.[1] It is a vibrant and challenging environment from both an operational and clinical perspective.[2] The number of people in an EC (patients, visitors, health professionals) not only affects service delivery locally but also in other areas of the hospital.[2] Globally, EC crowding has been recognised to adversely affect both patients and care providers.[3, 4] The Australasian College for Emergency Medicine describes EC crowding as the resource discrepancy between supply and demand; when the number of patients in the EC outstrips basic service capacity.[5] Unsurprisingly, crowding has a deleterious effect on patient care; a shortage of available beds in the hospital (not EC) is commonly identified as the key variable contributing to crowding.[6,7] In resource-limited settings there are for instance often shortages of step down beds for critical patients not eligible for ICU admission leading them to be admitted at ward. Quality of care delivered at the wards might be lower in some (especially) resource-limited settings than the quality of care received during hallway boarding in the EC. This perspective might alter the implications of crowding in our setting and especially its translation to even more resource limited settings. There is a paucity of research from Africa regarding local EC crowding. Anecdotally, the perception is that most African ECs are either full or overfull. Elsewhere, EC crowding has been meticulously studied; it is likely that local research has not followed suit given the relative lack of resources to do so.[8-12] We therefore undertook a research project at a busy district, public hospital in a middle income setting to describe the number and categories of people (patients, visitors, health professionals) in an attempt to describe crowding using minimal resources.

1.2 Problem statement

A recent study undertaken by Gilligan et al. showed that crowding of patients in the EC correlated with an increase in other people groups such as visitors or patients' relatives and staff from inpatient teams.[13] This study casts a different light on crowding, which had in the past been thought to mainly be a patient- related problem. An increase in staff members is bound to affect productivity, since staff will compete for the same EC resources such as computers, desk space

and equipment to manage a higher volume of patients.[14] When the EC is crowded with patients, visitors and medical staff numbers are likely to increase as well, as inpatient teams converge in EC to treat their patients there. We suggest that there is association between the volume of patients and staff that contributes to the EC crowd. This study has the potential to contribute to our limited knowledge about crowding locally without the need for specific resources. The findings of this study may inform further research on the subject and perhaps even justifying funding for more in-depth research that will require more resources. It is anticipated that the study methodology might be adopted as a rudimentary audit tool for evaluation of EC crowding in low- and middle income countries elsewhere.

1.3 Aim and Objectives

This study aimed to describe the EC crowd as a visual representation of crowding at a district public hospital on the outskirts of Cape Town, South Africa, by establishing the number and different categories of people (patients, visitors, doctors, nurses, paramedics, and others) at the predefined times: morning (09:00), afternoon (14:00) and evening (21:00) over a consecutive four week period.

To achieve this aim, the following objectives were listed:

1. To describe the different categories of people in the EC during the study period.
2. To describe the number of different categories of people in the EC during the study period.
3. To describe the EC occupancy rate over the study period.
4. (sub-objective) To describe the patient non-patient ratio over the study period.
5. (sub-objective) To describe the EC staff non-EC staff ratio over the study period.

In this thesis the core findings of the study are preceded by a literature review. The core findings itself are embedded in a post-print paper which has been accepted for publication in the African Journal of Emergency Medicine. The latter is supplemented by provision of further study findings and discussion.

1.4 Overview of Methodology

The study uses a prospective, cross-sectional study design. The principal researcher presented himself to the nursing and medical shift leads prior to commencing data collection. Collection was as headcount by category at 09:00, 14:00 and 21:00 every day for four weeks from 15th June 2016. These times are perceived to be the peak time points for EC crowding over the course of an average day. The data collection times overlap with ward rounds, relative visiting times and the early peak of the night shift. This was the same reasoning used in the Gilligan, et al. study.[13] The route of movement through the EC for data collection was in the following order: triage (including psychiatric area), resuscitation, ambulatory area (asthma), non-ambulatory area (trolley), procedure room and the paediatric EC area. This route of movement through the EC was followed to avoid duplication.

1.5 Overview of study setting

Khayelitsha hospital is the ideal setting for this study because the 47-space EC is 30% larger than any standard district hospital EC. The caseload is about 3000 patients per month which equates to around 100 patients per day. The reported bed occupancy levels in the hospital stand at 131%.[15] The hospital is usually busy on the first or last weekend of the month because it coincides with payday. The EC's burden of diseases range from penetrating traumatic injuries such as chest injuries, community assaults (resulting in traumatic brain injuries or burns) road traffic accident injuries to drug related psychosis.[15] Medical conditions are mainly as a result of inadequate potable water, unhygienic housing, and poverty-related infective illness such as HIV and Tuberculosis.[15] The EC sees about 700 children, which rise to 1200 per month between December and April during the diarrhoea and pneumonia surge season.[15] All persons in the EC at 09:00, 14:00 and 21:00 during the four week study period were included. The duration of data collection was discussed with a statistician. The research team noted the limitation this study placed on generalisability and bias of results. These limitations are expanded in detail in chapter 4.

The reporting structure of this thesis will be done in the following chapters.

Chapter 2 reviews the theoretical and empirical literature identifying major components of EC crowding globally. It also explores current literature on EC crowding in Africa.

Chapter 3 is the manuscript in article format.

Chapter 4 consists of additional methodology and findings of the study. The latter has been organised according to the objectives. The strengths and limitations of this study are also explained in details in this chapter.

Chapter 5 is the discussion of the study findings. It interprets the findings in chapter 4 according to the objectives.

Chapter 6 consists of the conclusion of the study. This includes the research team's conclusion and recommendations.

1.6 Definitions of key terms

Crowd: Crowd is defined as a "large number of persons gathered so closely together as to press upon or impede each other; a throng, a dense multitude".[16] Within this study context, it will refer to the volume and classification of all people (patients, visitors/patients' relatives and staff) gathered in the EC.

EC crowding: EC crowding is described by the Emergency Medicine Society of South Africa (EMSSA) as "a situation where EC function is impeded primarily because the number of patients waiting to be assessed, managed or admitted exceeds either the physical or staffing capacity of the department".[17]

Access block: The Australasian College for Emergency Medicine defines access block as "the situation where patients are unable to gain access to appropriate hospital beds within a reasonable amount of time, no greater than 8 hours".[5]

EC occupancy rate: EC occupancy rate is defined as "the total number of patients in the EC (sic) divided by the number of licensed EC beds".[18]

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Chapter 2: Literature review

2.1 Objectives of literature review

This literature review was performed in accordance with guidance provided by the University of Cape Town. The following were the objectives set out to be achieved by this narrative literature review:

1. To review the extent of EC crowding worldwide.
2. To review the theoretical and empirical background knowledge of EC crowding.
3. To review the concepts concerning EC crowding and how they are related.
4. To identify the various components that contribute to EC crowding.
5. To identify potential gaps in the literature regarding EC crowding.

2.2 Literature search strategy, including inclusion and exclusion criteria

Literature searches were conducted using two databases to identify relevant published articles– PubMed and ScienceDirect. Key words used were “Emergency Department OR Accident and Emergency Department OR Casualty OR Emergency Centre AND Crowding OR Congestion”. Words combination were as follows: ("emergency service, hospital"[MeSH Terms] OR ("emergency"[All Fields] AND "service"[All Fields] AND "hospital"[All Fields]) OR "hospital emergency service"[All Fields] OR ("emergency"[All Fields] AND "department"[All Fields]) OR "emergency department"[All Fields]) OR ("emergency service, hospital"[MeSH Terms] OR ("emergency"[All Fields] AND "service"[All Fields] AND "hospital"[All Fields]) OR "hospital emergency service"[All Fields] OR ("accident"[All Fields] AND "emergency"[All Fields] AND "department"[All Fields]) OR "accident and emergency department"[All Fields]) OR casualty[All Fields] OR (("emergencies"[MeSH Terms] OR "emergencies"[All Fields] OR "emergency"[All Fields]) AND centre[All Fields]) AND crowding[All Fields] OR “congestion”[All Fields]. Inclusion and exclusion criteria were applied to this cohort as follow:

2.1.1 Inclusion criteria

1 Articles published in the English language

2 Type of articles were: original research, systematic review, meta-analysis and editorial

3 Date of publication; 2006-Present

2.1.2 Exclusion criteria

1. Publications that did not include both crowding and one of the emergency centre (EC) variables
2. Abstracts and articles not published in English
3. Articles published before 2006

Forty-one articles from PubMed and 21 from ScienceDirect were selected and included in the final review. Abstracts of the identified documents were read and full text of relevant documents were retrieved for inclusion in the review. Reference lists of retrieved documents of high quality studies were also searched to identify additional publications. Finally, guidance was sought from peers and supervisors as well as to what should be included or excluded.

2.3 Quality criteria

Abstracts were collected using the search criteria described. Full-text articles were then obtained for abstracts that were relevant to the review objectives for closer review. Review articles, multicentre studies, studies with large sample sizes and studies in priority journals were included. Smaller studies that were well-designed and directly addressed the review objectives were also included. Additionally, assistance was sought from senior colleagues and experts on EC crowding both locally and overseas.

2.4 Interpretation of literature

2.4.1 Introduction

Emergency Centre crowding has been referred as one of the biggest challenges confronting policy-makers, emergency healthcare professionals (including physicians and nursing staff) and their patients globally. It has been discussed at length at academic conferences throughout the world.[1] Lay media coverage on this subject matter has also been reported in international sources including the Time magazines some years back.[1, 2] The main reason for the ongoing

discussion appears to be the reluctance to implement putative solutions, such as the expansion of the hospital capacity, the provision of care to only patients with emergency conditions, cessation of admitted patients boarded in the EC, expansion of the role of ancillary EC staff and hallway care. The EC remains unsafe when it is crowded and therefore quality emergency care is compromised, yet very little progress has been made to address this.[1]

EC crowding is described by Emergency Medicine Society of South Africa (EMSSA) as: "a situation where EC function is impeded primarily because the number of patients waiting to be assessed, managed or admitted exceeds either the physical or staffing capacity of the department".[3] The Australasian College for Emergency Medicine (ACEM) describes EC crowding as the resource discrepancy between supply and demand; when the number of patients in the EC outstrips basic service capacity.[4] According to the American College of Emergency Physicians (ACEP), EC crowding "exists when the institutional resources available are insufficient to meet the basic service needs of emergency patients."[5] The ACEP goes on to provide a list of signs that identifies the presence of crowding in the EC: patients treated in hallways, diversion of ambulances, EC full of boarded patients because there are no available inpatient beds, quality of care below the standards of the healthcare system.[5]

Crowd is defined as "a large number of persons gathered so closely together as to press upon or impede each other; a throng, a dense multitude".[6] A considerable number of available papers emphasise patient numbers vs. workload.[7-13] However, there is more to the EC crowd than just patient numbers; those who are associated with the patient care (EC clinical staff, inpatient clinical staff, and other auxiliary staff) as well as visitors should be considered.[14] Within our study context, a crowd refers to the volume and classification of all people, including patients, visitors, doctors, nurses and others gathered in the EC such as prehospital staff, healthcare students, security staff, porters, cleaners, catering staff, administrative staff, etc. For this review, emphasis are placed on the following areas: magnitude of EC crowding, causes of EC crowding, effects of EC crowding, measures for assessing EC crowding and the affected patient population.

2.4.2 Magnitude of the EC crowding problem

Crowding is not a problem for the EC alone but rather a symptom of a healthcare system in crises; it affects all agencies, facilities, and providers of healthcare regardless of status.[15,16] Likewise the

cause of EC crowding is not by the EC's own making, but rather by perverted hospital-wide systems. Sadly patients and others who present to the EC rarely possess an understanding of the magnitude of the problem with the blame usually falling to the EC for poor efficiency. There is generally a consensus that EC crowding is a reflection of supply and demand mismatch within the healthcare system. This results in three key effects: the extent of the problem is worsening, the situation is associated with negative healthcare outcome, and it is associated with patient centeredness, hospital systems and clinical factors. [16, 17]

2.4.2.1 EC crowding is worsening

In Olshaker et al's. survey of directors in some USA hospitals, 91% of them reported that EC crowding was a problem in almost every state, and it is worsening.[18] This is because till date stakeholders are yet to fully implement studied suggested solutions to this problem. Even in the Netherlands where the problem of EC crowding is reported to be milder; a survey of EC management members including medical managers or emergency physicians (EP), nurse managers, and staff nurses in 2012 revealed that 68% of them reported that their ECs were crowded daily.[19] In an international review of crowding performed in Australia, Canada, Denmark, Finland, France, Germany, Hong Kong, India, Iran, Italy, The Netherlands, Saudi Arabia, Spain, Sweden and the United Kingdom; it was noted that long delays, boarding times in excess of eight hours and EC crowding were commonplace in all of these countries. Presence of universal health care made little difference to crowding numbers.[20,21] Very few researches on crowding in low- and middle income countries (LMICs) were found.[22- 25]Anecdotally it is perceived to be high. In a nutshell, ECs in high and middle income settings are crowded and crowds seem to be worsening, not improving.

2.4.2.2 EC crowding is associated with negative healthcare outcomes

Derlet et al., and Boyle et al. have listed some of the negative healthcare outcomes of EC crowding, as follow: ambulances being diverted, prolonged waiting times and patient dissatisfaction, prolonged suffering and pain, compromised patient safety and privacy, staff dissatisfaction and increased attrition rate because of increased workload on them, clinical productivity and effectiveness being decreased, miscommunication amongst staff members, violence, medico-legal issues, negative effects on teaching and research, and inability for

effective evacuation during emergency situations.[1, 26] These negative healthcare outcomes may further exacerbate the problem of EC crowding. [27] As a result, it affects all sectors of the health care system.

2.4.2.3 EC crowding is associated with patient centeredness, hospital systems and clinical factors

The Institute of Medicine (IOM) defines patient centeredness as: "Providing care that is respectful of, and responsive to, individual patient preferences, needs and values, and ensuring that patient values guide all clinical decisions."[28] The eight principles of a patient centered care include, respect for patient preferences, coordination and integration of care, information and education, physical comfort, emotional support, involvement of family and friends, continuity and transition, and access to care.[29] When the EC is crowded, it is associated with a negative patient centeredness because it affects the efficiency of the department which in turn impacts negatively on patient-centered care.[30] For example, the patients will not get enough attention from the care providers when the EC is congested. As a result, quality of care is below the set standards of care by stakeholders. EC crowding is associated with hospital systems because when there are no robust hospital policy interventions, crowding creates overcrowding; and there is enough evidence to prove that multidisciplinary team interventions have yielded good results.[31] There is therefore, the need to put the right systems in place to allow all departments and units in the hospital to interact among themselves. These interventions, when implemented, should be healthy enough to affect areas such as ambulance services, ECs, all inpatient wards, diagnostic services, operating theatres, and intensive care units. These measures will have direct impact on the clinical factors.[30] It is clear from the above reasons that these effects of EC crowding affect both the patient and the hospital as a whole.

2.4.3 EC crowding in an African context

There is a growing concern in Africa to approach and study this challenge comprehensively because it is perceived to be a bigger problem in the African region than elsewhere.[3, 22-25] Yet very little research on EC crowding have been conducted. This is mainly because African countries lack the resources to perform a more detailed investigation. Many low resourced settings would have similar restrictions in evaluating crowding given that the vast majority of

systems and data available to describe flow locally are fairly rudimentary, paper-based and lacking an electronic record. In contrast, high resourced settings data is collected by well-trained personnel using standardised data abstraction forms. Stakeholders such as patients, clinicians, researchers, and others will benefit if this problem can be comprehensively assessed. However, before anything can be assessed it needs to be adequately defined. The purpose of this study was to describe the crowd as a visual representation of crowding. The study provides a snapshot of the size of the crowd and what it is made up of. We felt our study is an important one to show how much can be gained just by describing the crowd as this could be easily replicated in a resource limited setting. Very little information exists about crowds and crowding within the local context. This happens to be a key objective of this thesis.

2.4.4 Causes of EC crowding

A number of factors account for EC crowding. However, three main causes have been identified that summarises these factors. These are inadequate inpatient capacity, higher severity of illness, and hospital system restructuring. [1,16,32] These will be briefly unpacked below.

2.4.4.1 Inadequate inpatient bed capacity

Within a period of 18 years, the total number of US hospital inpatient beds have reduced by 39% as a result of management decision to contain cost, but with a negative impact on patient safety.[16] Inadequate inpatient bed capacity appears to adversely impact on throughput processes, including registration, triage, room placement, initial provider evaluation, diagnostics and treatment.[33] These factors are reported to be major contributors to EC crowding as it results in access block. [16, 33] In resource-limited settings crowding due to access block may have deleterious effect on patient care. However, in these settings, there is often shortage of step down beds for critical patients not eligible for ICU admissions leading them to be admitted in the wards. Quality of care delivered in the wards might be lower in some cases than quality of care received during hallway in EC. Sadly, policy-makers are sluggish in addressing this issue.[1]

Large numbers of patients who have been boarded in the EC wait for inpatient beds for an extended period of time.[34-38] One explanation could be that ECs have physicians who continuously assess their patients' clinical needs to decide whether to move them to the inpatient wards, refer them to other specialised hospitals or to discharge them. In contrast,

inpatient teams only make periodic decisions on their patients. The result is an imbalance between patient movements in the EC and those in inpatient wards, leading to uncoordinated flow between and from the two that further worsens crowding. This uncoordinated flow will manifest in the EC with patients been treated in the hallways.

2.4.4.2 Higher severity of illness

Given an increasing burden of disease globally coupled with an aging population, higher severity of illness continues to increase its contribution to crowding in ECs.[16] The number of elderly patients who presented to an EC with chronic medical conditions such as cardiovascular diseases, arthritis, lung diseases, adult diabetes, kidney and bladder problems, or waiting for long-term care treatment have increased exponentially in Canada and the USA during the past decades.[16,32,39] Some ECs have to perform protracted high care or an intensive care due to an increased pressure from advanced ailments. [16] Higher severity of mental health related conditions such as substance use disorders and co-occurring psychiatric disorders in many countries including the USA, also contribute to an increase of EC visits. In 2007 alone nearly 12 million EC visits were due to mental health or substance use in adults.40 The increase in illness severity now places a huge burden on the finite resources available to ECs

2.4.4.3 Hospital system restructuring

EC crowding has undoubtedly also been the result of a reduction of the number of ECs – either by merging services or by closing them down.[17, 39] As evidenced in California hospital ECs from 1990 to 1999, a 12% reduction in the number of ECs resulted in a 27% increase in EC attendance.[17, 21] It is challenging to comprehend why ECs are closed or merged if all other factors point to an increased demand on emergency services. Decreasing inpatient capacity defers inpatient responsibility to the remaining ECs which are already struggling with increased numbers and illness severity given limited resources, creating a perfect storm that impacts not only quality of care, but more important, patient safety. The result is pooling of resources to attend to the sickest, with predictable long waiting times for those less sick.

2.4.4.4 Effects of EC crowding

Several works have been published on EC crowding by accredited researchers; it has been established that crowding adversely affects acute care delivery, likely even resulting in increased

morbidity and mortality.[16,32,41-47] A US study studied the association between EC crowding and mortality. They found that even though there were confounders, the study findings suggested an association between mortality and crowding.[47] In the same article, it was observed that critically ill patients who stayed in the EC for more than 6 hours before intensive care unit transfer had an increased length of stay there and in the hospital, resulting in an increased mortality. [47] Elsewhere, Australian researchers calculated the association between EC crowding and ten-day mortality; EC occupancy, as quantified in their study, was the total number of patient care hours during the shift divided by eight-hour intervals which coincided with the three shifts of the day. They concluded that the relative risk of ten-day mortality was 1.34 for a crowded shift versus a non-crowded shift [95% CI (1.04-1.72)].[45] Sprivulis et al., also from Australia, conducted a study in the same year to find out about the association between EC crowding and mortality. They described an increased mortality at two, seven, and 30 days, that was statistically significant with hazard ratio of 1.3, 1.3, and 1.2.[44] The American College of Emergency Physician task force reported on boarding and EC crowding as follow: 1. patients wait too long to receive emergency care, 2. there is significant increase in complications as a result, 3. it increases access block which worsens access to emergency care, 4. it increases the number of patients who leave before being seen, 5. it increases medical errors, 6. it causes deaths, 7. it causes ambulance diversions, 8. it increases medical negligence claims, which increases Medicare costs for everyone, and 9. it interferes with continuity of patient care affecting patient- centred care models.[42] Collis, in a poignant review, confirmed what is known of the adverse effects of EC crowding on diverse areas of healthcare delivery and patient experience.[41] Picton, in an editorial to Collis' publication noted that crowding was a global challenge since it is faced by healthcare providers in the ECs all over the world; the result of inadequate patient access to healthcare services such as walk-in centres, polyclinics, urgent care centres and general practitioners' surgeries.[46]

But is there any evidence to the contrary? Do better systems result in less crowding? A recent article described the relationship between EC crowding and a number of studied interventions at EC level (computer assisted triage, bedside registration, fast track, zone nursing, increased EC treatment spaces, EC observation unit and physical expansion of EC), and hospital level (bed czar, bed census availability, pooled nursing, board patients in inpatient hallways, avoid elective admissions diversion, full-capacity protocol).[48] They concluded that ECs that adopted a significant number of the studied interventions saw less crowding. However, most crowded ECs are yet to adopt any of these interventions.[48] Given the link between crowding and poor outcome, it follows that implementation of these interventions could likely curb the negative effects of EC crowding.

2.4.5 Measures to assess EC crowding

Multiple methods of measurement have been suggested by leading researchers in the field to quantify EC crowding.[49-52] A valid and accurate method of quantifying workload and crowding in an academic EC was undertaken by Weiss et al. in 2004.[49] Subsequently, in 2006, the same researchers assessed the value of two primary scales available: National Emergency Department Overcrowding Scale (NEDOCS) and Emergency Department Work Index (EDWIN) to predict crowding over a ten-day period. They concluded that both scales have high areas under the receiver operator characteristic (ROC) curves. This means both primary scales have validity to measure crowding since they are appropriately sensitive and specific.[49] In another study, Jones et al. evaluated two other scales namely the Real-time Emergency Analysis of Demand Indicators (READI) and the Emergency Department Crowding Scale (EDCS). They concluded that apart from NEDOCS and EDWIN, a single variable from the READI, bed ratio (or the relationship between the number of patients and the number of treatment spaces) effectively generated predictions of EC crowding.[50] Hoot et al. also suggested a single metric, suggesting that EC occupancy level should be used for measuring crowding in the EC. They argued that instead of the four scales aforementioned (NEDOCS, EDWIN, READI, EDCS), EC occupancy is a simple metric that can be easily calculated. Occupancy level was defined as 100 multiplied by the number of patients in licensed beds and overflow locations including hallways and chairs divided by the number of licensed treatment beds.[51] Emergency Centre occupancy levels forecast EC crowding in real-time and it is more reliable to implement in practice. McCarthy et al. defined another single metric,

EC occupancy rate as “the ratio of the total number of patients in the ED to the total number of ED treatment bays per hour”. The value of the EC occupancy rate is that it can be calculated in real time where patients’ registrations and discharges can be tracked electronically and the number of licensed beds is known.[52]

Factors that could influence hospital occupancy levels such as the ability to transfer patients that have been boarded in the EC to hospital beds may include availability of beds, local service structure, ancillary services, nursing staff and nursing ratios.[53] To take matters one step further, a higher hospital occupancy level results in EC crowding as this has a negative effect on throughput.[54] Effectively there is an association between hospital occupancy and EC occupancy levels; a high EC occupancy level is therefore mainly a reflection of hospital occupancy including inpatient wards such as medicine, surgery, operating theatres, high care and intensive care units. It is worth noting that high occupancy level hospitals may not necessarily treat more patients as capacity is often made up of protracted length of stay.[53] As discussed earlier, a higher occupancy begets crowding and it negatively impacts on both patients and the patient associated population.

A more valid and accurate measure of assessing EC workload and crowding such as NEDOCS, EDWIN, READI and EDCS should have also been used in this study; however, resource restrictions render a more detailed study less achievable. We used the single metric (EC occupancy) that could be easily calculated due to difficulties of pursuing the earlier mentioned measures in our local setting. Our study sought to describe the crowd as a visual representation of crowding.

2.4.6 Patient associated population and EC crowding

It is argued that those who are associated with the patient crowd – visitors, doctors, nurses, pre-hospital staff, healthcare staff, healthcare students, security staff, porters, catering staff, administrative staff, etc. – need to be included in EC research.[14] For one reason staffing ratios such as physician and nursing to patients are likely to influence EC crowd.[53] The projected USA population growth by 2050 is 420 million, however, medical school enrolments have remained constant. It was estimated that there were only 26 physicians and 94 nurses per 10000 population in the USA.[55] However, putting that in perspective, between 2007- 2012 there were an estimated average of 32 physicians and 86 nurses per 10000 people in high income countries

compared to 14 physicians (56% less) and 27 nurses (69% less) in low- to middle income countries.[56] The World Health Organization (WHO) currently estimates the density of the health care workforce for the Africa region as a mere three physicians per 10000 population compared to 32 in the Europe region and 22 in the America region; for nurses the density is estimated as 12 compared to 80 in the Europe region and 45 in the America region.[57] Simply put, African hospitals are likely more crowded than the US hospitals; subsequently it must be assumed that the patient access to care is impacted more negatively than in high income countries.

Healthcare staff stationed in, or transiting through but providing care in the EC include: onsite staff (EC doctors, EC nurses, allied health professionals, social workers, and psychiatry services); visiting clinical staff (doctors from inpatient units, nurse educators, and forensic medical officers); and others (liaison staff, care coordinators, disability and respite carers, orderlies, pastoral care staff, teaching staff, students, researchers, ambulance, transport, retrieval service, police, fire brigade, state emergency service personnel, administration staff, security personnel, cleaning staff, maintenance staff, volunteers, and funeral service personnel).[58] Interestingly Gilligan et al. described that patient volumes affected staff numbers so that more patients in the EC resulted in more healthcare staff.[14] In a nutshell, they concluded that patient crowding creates staff crowding. Given finite resources and space, which now have to be shared by a larger cohort of healthcare staff, the effect on efficiency (and by extension quality and safety of care) is likely to be negative as well.

This happens in much the same way as an increase in EC patients contribute to an increase in visitors in the EC.[14] In a qualitative study conducted in an Ireland EC in 2007 patients and their relatives described the EC as crowded – resembling a disaster zone. They also described the environment as dirty and lacking resources. The patients and their relatives suggested measures such as, the reduction of waiting times, improved communication systems, improved security, and a better privacy within the EC.[59] Time of the day was found to be predictive of visitors' numbers. There were significantly more visitors with patients in the afternoons and evenings compared to mornings ($p < 0.001$). In stark contrast there were significantly more staff in the morning than in the afternoons and evenings ($p<0.001$).[14]

An increase in the numbers of visiting clinical staff and other people groups is bound to affect productivity. This is because physicians from inpatient teams such as medicine, surgery,

obstetrics and gynaecology, paediatrics will converge in the EC to treat their patients and will compete for the same EC resources including computers and desk space equipment to manage a higher volume of patients. This will adversely affect workflow.[60] Poor workflows may impede coordination and communication in the EC. It may also increase interruptions including delays, needless pauses and rework, gaps in workaround, and gaps where steps are missed.[61]

EC crowding could influence on-site healthcare staff and others associated with the patient. Some of the associated effects are burnout, ill-health and absenteeism. As a result of these effects, there is an increasing attrition rate of senior and experienced emergency healthcare staff. Recruitment of inexperienced and junior ones, or locum agency staff, to fill the gap therefore becomes the alternative. In an academic EC, trainees and educational programmes could be compromised.[62,63] For example, a prospective cross-sectional study evaluated the impact of EC crowding on a residency educational programme. The conclusion of the study was that fewer patients and procedures were undertaken when the EC was crowded.[64] This finding suggests that crowding has a detrimental effect on service delivery as well.

One of the most important on-site clinical staff groups associated with patient care in the EC is the EC doctor. Derlet et al. described a case study of a crowded EC where patients were treated in crowded hallways. A senior EC doctor on duty assessed a patient with shortness of breath in the hallway, and requested several diagnostic tests including an electrocardiogram (ECG). The doctor did not personally interpret the ECG due to crowding and patient load, but relied on the interpretation of a more junior staff member. The patient was treated and discharged, only to return two days later in cardiac arrest. An autopsy report revealed acute and chronic pulmonary emboli as the cause of death. The doctor involved was eventually named and shamed by the medical board and lost his license to practice.[65] This sad event underscores unreliable safety in crowded ECs. Moreover, it underscores the consequences to staff working in conditions not due to their own creation.

Nursing staff make up a large proportion of on-site clinical staff in the EC. Nurses carry out instructions given to them by the physicians, and also to undertake other ancillary services. When an EC is crowded with patients, nursing staff are confronted with several situations which could impact on their workflow.[66] The nurse-patient ratio is what is used to measure the workload unit level. So, when nursing staff workload increases – as the case of EC crowding – it would likely

have negative consequences for patients. A simple solution would be to either increase the numbers of nurses or reduce the number of patients. Even though this reasoning appears simple enough, it is not practical given expense to recruit more nursing professionals and the resulting staff crowding to compensate for patient crowding. Besides, shortages of nursing staff in the healthcare system means that the pool from whence staff are drawn also has limits.[66] Similarly, Carayon et al. argues that this type of reasoning ignored the contextual and organizational characteristics of the system such as the setting, organisational layout and information technology. These factors may all affect workload negatively.[66]

2.5 Summary

This narrative literature review yielded a considerable number of published materials on crowding. However, these were mostly related to patient numbers and workload. Only a few published articles were available that directly addressed the patient associated crowd (workforce and visitors). This appears to be a relatively unresearched area. Not only that, but methods required to research crowding are likely to be out-of-reach for many low- and middle income, understaffed, paper record-based, emergency centres.

To provide context to the rest of the thesis, this review focused on the magnitude of EC crowding, causes of EC crowding, effects of EC crowding, measures to assess EC crowding, and patient associated population related to crowding. There was a general consensus that the extent of crowding seems to be worsening, that it is associated with negative healthcare outcome, and that it is contributed to by patient centeredness, hospital systems and clinical factors.[16, 17] The international perspective on EC crowding demonstrates that this challenge is one of the biggest confronting hospitals throughout the world.[20, 21] Resultantly it is also a major challenge faced by emergency healthcare professionals and their patients.[22] There appears to be plenty of evidence from Western nations to prove that multidisciplinary team interventions yield reassuring results, despite oddly being shunned by health systems.[31] A major concern remains low- and middle income countries, given only a few published materials that corroborate anecdotal evidence that crowding exists in the Africa continent too.[3, 22-25] This must change.

There appear to be three overarching causes of EC crowding, namely: inadequate inpatient capacity, higher severity of illness and, hospital system restructuring.[1, 16, 32] Most researchers

agree that inadequate inpatient bed capacity remains a key contributor of EC crowding.[16, 20-25] Their work suggests that access block to inpatient beds results in large numbers of EC patients awaiting admission.[6, 34-38] Several recent publications established that crowding adversely affects care delivery, possibly even resulting in increased morbidity and mortality.[16, 32, 41-47] Despite this, proven interventions at EC and hospital level continue to be shunned.[48]

Multiple methods of crowding measurements have been recommended.[49-52] These include NEDOSCO, EDWIN, READI, EDCS and EC occupancy rate. It is clear that simple measurements related to occupancy are at least as effective in describing crowding as the more complex methods.[51, 52] This is mainly because a high hospital occupancy level is multifactorial.[53] There remains little doubt that a higher hospital occupancy level leads to EC crowding and that this has a negative effect on throughput and patient safety.[54]

Few published articles were found that dealt directly with patient-associated crowding. [14, 53, 43-66] Despite this there were consensus that high patient volumes negatively affected visitors and healthcare professionals. Boarded patients contribute to considerable workload for emergency healthcare professionals, and they also contribute to a significant increase in the number of visitors and healthcare staff in the EC. In turn, the increase in numbers of healthcare staff affects productivity, as healthcare teams have to compete for shared EC resources in a limited space. The result is a negative effect on EC workload and workflows, which in turn have implications for patient safety issues, burnout, ill-health and absenteeism, increased attrition rate of senior and experienced EC staff and compromised educational programmes in academic health institutions. Gilligan et al. rightly recommended that more research be conducted on the effects of patient associated population.[14] As far as we could tell, no work has been done in the African context on patient-associated crowding. It is likely that the problem is at least similar. However, in a low resourced environment the effects of patient- associated crowding could potentially be more detrimental given fewer resources and higher patient loads.

2.6 Identification of gap and need for research

The narrative literature review reveals a gap in knowledge on EC crowding, particularly in the African context, related to patient-associated crowding. This is important as it has a wide-ranging effect on quality, safety, efficiency, and cost for the entire healthcare system. Given limited

resources within low- and middle income settings this is an important focus for improvement. However, first an understanding of the magnitude of the problem is required.

It is for this reason that this thesis aims to describe the EC crowd, including patients, staff and visitors, by establishing the number and different categories of people at predefined times as was done by Gilligan, et al. This thesis has the potential to contribute to our limited knowledge on crowding locally and offer recommendation for further actions and research. This is one of the first studies to document crowding locally and is likely to present findings many local public ECs would be able to relate to. It is anticipated that the study methodology might be adopted as an audit tool for evaluation of EC crowding in other low- and middle income settings.

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Chapter 3: Key methods and findings

Reference

Ahiable EK, Lahri S, Bruijns SR. Describing the categories of people that contribute to the crowd at an urban, public emergency centre in Cape Town, South Africa. *Afr J Emerg Med*. 2017 [forthcoming]

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3.1 Declaration from authors and co-authors

The following co-authors contributed to the paper: Drs. Stevan R Bruijns and Sa'ad Lahri. In the case of Chapter 3, contribution by authors to the work was as follow:

SRB and EKA came up with the original idea for replicating the Gilligan study. Planning was undertaken by SRB, EKA and SL. The first draft of the proposal was written by EKA. This was reviewed by SL and, finally refined and approved by SRB. EKA collected and managed the data. The statistical analysis was done by EKA with some input from SRB. The draft manuscript was written by EKA. This was revised by SL and, refined and approved by SRB. All authors approved the final forthcoming version and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Extent of contribution: EKA: 85%; SRB: 10%; SL: 5%

Declaration by co-authors

The undersigned hereby certify that:

1. The above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.
2. They meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
3. They take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
4. There are no other author of the publication according these criteria;
5. Potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
6. The original data are stored at the following location and will be held for at least five years from date indicated below Location of stored data: All paper-based data are kept securely by Dr. Ahiable. Electronic data are kept securely on the University of Cape Town's server with access from the division offices by principal researchers.

Signed by candidate

signature removed

Dr Stevan R. Bruijns Date: 2017/03/05

Signed by candidate

signature removed

Dr Sa'ad Lahri Date: 2017/03/02

3.2 Published research paper

Describing the people categories that contribute to the crowd at an urban, public emergency centre in Cape Town, South Africa

Abstract

Background: Emergency Centre (EC) crowding has globally been recognised to adversely affect patients, staff and visitors. Anecdotally, local ECs are perceived to be fairly crowded, however, not much is known about the size of this crowd and what constitutes it. Although more reliable, resource restrictions render more detailed flow studies less achievable. This study describes the EC crowd at Khayelitsha hospital as the number and different categories of people, at predefined times during the day over a four-week period.

Method: A prospective, cross-sectional, design was used. Headcounts were made by predefined groups at 09:00, 14:00 and 21:00 every day for four weeks. Predefined groups included doctors, nurses, visitors, patients, and other allied health staff. Summary statistics were used to describe the data. Precision was described using the 95% confidence interval.

Results: A total of 16353 people were counted during the study period. On average, 6370 (39%) of the groups were staff, 5231 (32%) were patients and 4752 (29%) were visitors. Of the staff, 586 (3.6%) were EC doctors, 733 (4.4%) were non- EC doctors, 1488 (9%) were EC nurses, and 445 (3%) were non-EC nurses. Although patient numbers in the EC remained constant, visitors and non-EC staff varied significantly with visitors peaking in the afternoon and non-EC staff drastically reducing in the evening. The EC was consistently crowded – average occupancy: 130%.

Conclusion: Staff levels fluctuated predictably reducing at night and over weekends, however, patients remained constant. Non-EC doctors more than doubled during the day on week shifts, in significantly more numbers than EC doctors, suggesting that many of the patients in the EC were likely to be admissions boarding in the EC. Visitor numbers were substantial during visiting

hours and would have further aggravated crowding. Resource-light studies involving flow are important to explore crowding in low- and middle income settings.

Introduction

The Emergency Centre (EC) is a complex clinical environment with unpredictable workflow and at times, a propensity for filling up, or in other words become crowded.[1] It is a vibrant and challenging setting from both an operational and a clinical perspective. The number of people in an EC (including patients, visitors and staff) not only affects service delivery locally in the EC, but also delivery in other areas of the hospital.[2] Globally, EC crowding has been recognised to adversely affect both patients and care providers.[3, 4] The Australasian College for Emergency Medicine describes EC crowding as the resource discrepancy between supply and demand—or, in simpler terms, when the number of patients in the EC outstrips basic service capacity.[5] Unsurprisingly, crowding has a deleterious effect on patient care and has been the topic of many studies globally.[6, 7, 8, 9, 10, 11, 12] However, there is a paucity of research from Africa with regards to EC crowding locally. Anecdotally, the perception is that most African ECs are either running at or over capacity. However, this perceived crowd has never been proven or described, likely due to lack of systems and resources. Despite this setback, it is fair to assume that patient numbers likely do overwhelm the health care workforce; according to the 2015 World Health Organization (WHO) statistics, the density of the health care workforce per 10000 population in the Africa region was a mere three physicians compared to 32 in the Europe region. For nurses, the density was 12 compared to 80 in the Europe region.[13] Although various ways exist to describe patient flow through ECs, not many would be achievable within a setting that lacks the finances, systems and resources to do so.

In a study undertaken by Gilligan et al. increases of patients in the EC correlated with increases of other people groups such as visitors and staff.[14] This particular study cast an interesting light on crowding, which had in the past been thought to mainly be a patient related problem and is usually described in terms of flow and access block. When the EC is crowded with patients, medical staff is likely to increase as well, as inpatient teams converge in the EC to treat their patients there. However, an increase in staff members is bound to affect productivity, since staff will compete for the same EC resources (for instance computers and desk space) to manage higher volumes of patients in a smaller area.[15] In a way, describing the crowd provides an indirect litmus test to reveal the extent of crowding, and thus whether further investigation of flow (at the expense of greater resources) are justified. We were interested to know whether, given

lower physician density locally, there is also an association between the volume of patients and other people groups contributing to the EC crowd. This study aimed to describe the EC crowd at a district public hospital on the outskirts of Cape Town, South Africa, by establishing the number of the different categories of people (patients, visitors and EC staff) at 09:00, 14:00 and 21:00 over a four week period.

Methods

A prospective, cross-sectional design was used for this study. The study was undertaken at Khayelitsha hospital in Cape Town, a 47 bed and ambulatory space EC which forms part of a 230-bed district, public referral hospital. It provides a 24- hour EC, as well as inpatient paediatrics, obstetrics, gynaecology, surgery, and medicine of which all but the EC, medicine and paediatrics are family medicine run. The EC sees around 3000 new patients per month with a reported inpatient bed occupancy level at around 131%.[16] The EC sees about 700 children, rising to 1200 per month between December and April during the gastroenteritis and pneumonia surge season.[16] The EC has a five-bedded resuscitation area, an eight-reclining chair, non-ambulatory area, and 14-bedded trolley area. The paediatric EC has eight beds and the EC run, paediatric overnight ward has six beds. The minor illness and injury area has three consultation rooms, each with one examination bed, and the procedure and two isolation rooms have a bed each. The EC's poverty-related, burden of disease ranges from penetrating traumatic injuries (e.g. chest injuries, community assaults and road traffic accidents) through drug related psychosis, to infective illnesses such as HIV and tuberculosis.[16]

For the study, all persons that were in the EC over the space of two hours from 09:00, 14:00 and 21:00 during a four-week study period during June 2016 were included. Categories of people were predefined and included doctors (EC, non-EC), nurses (EC, non-EC), visitors, patients, security staff, porters, catering, administration, paramedics and various staff from other departments. Doctors were sorted according to specialities and a space was provided to include undefined categories. The three time-slots were selected because these were perceived to be the peak crowding times (ward-rounds, visiting hours), using the same reasoning as described by Gilligan, et al.[14] Duplication was minimised by using a predetermined route through the EC for each data collection.

Data were analysed using Excel (Microsoft Office, Redmond, USA). Different people groups were expressed as proportions with the mean used to describe central tendency, standard deviation to describe spread and the 95% confidence interval to describe precision. Various patients to group ratios (for visitors and staff groups) were calculated to see how these changed over time. These ratios were compared between time-slots using the Chi-Square test (significance was described as a $p < 0.05$). Occupancy was defined as the number of patients per available EC spaces. This was graphically expressed to show change over time. The study received ethical approval from the University of Cape Town, Human Research Ethics Committee.

Results

A total of 16353 people were counted during a study period lasting 29 days (this is a mean of 564 people per day and 188 per data collection time-slot). The breakdown of individuals at each stage of the study is depicted in Figure 1.

[Figure 1 near here]

Of the 733 (4.4%) non-EC doctors, 368 (50%) were from medicine, 147 (20%) were from surgery, 93 (13%) were from Obstetrics and gynaecology, 62 (8%) were from paediatrics, 27 (4%) were from psychiatry, 26 (4%) were research clinicians, 7 (1%) were from anaesthetics and 3 (0.4%) were from family medicine. Of the (2117) 13% ancillary staff, 682 (32%) were catering and housekeeping, 532 (25%) were security, 331 (16%) were porters, 249 (12%) were administrative staff, 55 (3%) were laboratory staff, 52 (2%) were radiographers, 39 (2%) were non-clinician, research assistants, 32 (2%) were pharmacy staff, 30 (1%) were transport staff, 28 (1%) were maintenance staff, 23 (1%) were dieticians, 22 (1%) were physiotherapists, 17 (1%) were central sterile services staff, 12 (1 %) were stores staff, 7 (0.3%) were forensic pathology service staff, 4 (0.2%) were undertakers, 1 (0.04%) was an occupational therapist and 1 (0.04%) was a psychologist.

Table 1 shows the number of different categories of people in the EC during the 09:00, 14:00 and 21:00 time-slots over the 29-day study period. Confidence intervals revealed significant differences between time-slots within groups and between groups. Overall, afternoons were significantly more crowded and evenings significantly less. Visitor numbers were significantly higher in the afternoon compared to mornings and evenings. The numbers of EC clinical staff and

EC doctors were significantly less in the evenings and weekend shifts compared to week shifts. EC nurses were significantly fewer on weekend shifts than on week shifts. The findings were similar for non-EC clinical staff, doctors and nurses. In contrast, patients remained constant, with no significant difference in confidence intervals seen between shifts. Compared to non- EC doctors, there were significantly fewer EC doctors during week shifts, specifically at 09:00, 14:00.

[Table 1 near here]

Figure 2 graphically displays the differences between patients, visitors, EC clinical staff, non- EC clinical staff, EC doctors and non-EC doctors for the average shift at the three different time-slots, a week shift, weekend shift and an average shift. The only significant patient ratio was patient to visitors; the 14:00 time-slot ratio was significantly different from the ratios at 09:00 and 21:00 ($p<0.001$).

[Figure 2 near here]

The mean bed occupancy rate was 130%, 128% and 132% for the 09:00, 14:00 and 21:00 time-slots respectively. Overall, bed occupancy was highest on Mondays and lowest on Sundays. Occupancy never dipped below 100% at any point during the study. Figure 3 shows the trend for the mean bed occupancy rates for each data collection time-slot for a particular day of the week.

[Figure 3 near here]

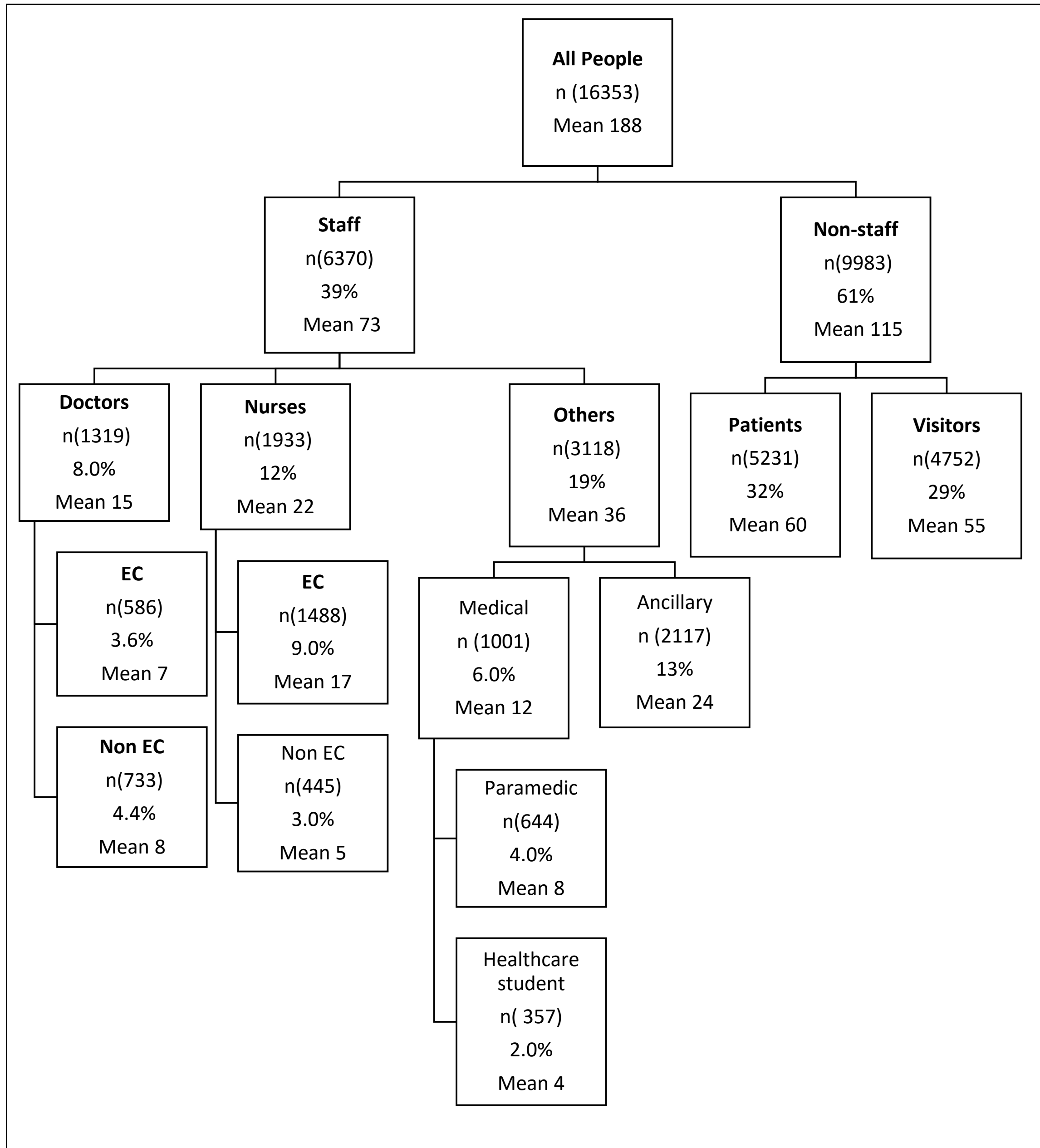

Figure 1. Flow chart of all people in the Emergency Centre and mean number per data collection time-slot over the 29-day study period

Table 1. The number of different categories of people in the EC during the 09:00, 14:00 or 21:00 time-slots over the entire study period

	09:00 time-slot			14:00 time-slot			21:00 time-slot			Weekday (total for day)			Weekends (total for day)			Total for day		
Groups	**n (%)**	**Mean ± SD**	**95% CI**	**n (%)**	**Mean ± SD**	**95% CI**	**n (%)**	**Mean ± SD**	**95% CI**	**n (%)**	**Mean ± SD**	**95% CI**	**n (%)**	**Mean ± SD**	**95% CI**	**n (%)**	**Mean ± SD**	**95% CI**
All	4854	168±35	154.7- 181.3	7587	262±44.3	245.2- 278.8	3912	135±24	125.9- 144.1	12130	578±84	540.0- 616.0	4223	528±42	493.0- 563.0	16353	564±77	535.0- 593.0
Patients	1751 (36%)	61±13	55.0- 66.0	1717 (23%)	60 ±12	55.0- 65.0	1763 (45%)	61±11	57.0- 65.0	3849 (23.5%)	183±33.3	167.8- 198.2	1382 (8.5%)	173±19.3	157.0- 189.0	5231 (32%)	180±30	169.0- 191.0
Visitors	773 (16%)	27±11	23.0- 31.0	3461 (46%)	119±32	107.0- 131.0	518 (13%)	18±8	15.0- 21.0	3366 (20.6%)	160±38.1	142.7- 177.3	1386 (8.5%)	173±27.6	150.0- 196.0	4752 (29%)	164±36	150.0- 178.0
EC clinical staff	721 (14.9%)	25±2	24.2- 25.8	732 (9.6%)	25±3	24.0- 26.0	621 (15.9%)	21±1.8	20.3- 21.7	1541 (9.4%)	74±3.6	72.4- 75.6	533 (3.3%)	67±3.3	64.2- 69.8	2074 (12.7%)	72±4.6	70.2- 73.8
EC doctors	214 (4.4%)	8±1.3	7.5- 8.5	230 (3%)	8±2.4	7.1- 8.9	142 (4%)	5 ±1	4.6- 5.4	454 (2.8%)	22±2.9	20.7- 23.3	132 (0.8%)	17±1.9	15.5- 18.5	586 (3.5%)	20±4	19.0- 21.0
EC Nurses	507 (10%)	17±2	16.0- 18.0	502 (7%)	17 ±2	16.0- 18.0	479 (12%)	17±1	16.0- 18.0	1087 (6.6%)	52±3	50.6- 53.4	401 (2.5%)	19±2.9	16.5- 21.5	1488 (9%)	51±3	50.0- 52.0
Non- EC clinic al staff	476 (10%)	17±5	15.0- 19.0	480 (6%)	17±6	15.0- 19.0	227 (6%)	8±2	7.0- 9.0	947 (5.8%)	45±5.9	42.3- 47.7	231 (1.4%)	29±4.8	25.0- 33.0	1178 (7.2%)	41±9.2	37.5- 44.5
Non- EC doctors	308 (6%)	11±4	9.0- 13.0	332 (4%)	12±6	10.0- 14.0	98 (2%)	4±1	3.0- 5.0	612 (3.7%)	29±5.5	26.5- 31.5	121 (0.7%)	15±2.6	12.7- 17.3	733 (4.4%)	26±8	23.0- 29.0
Non- EC nurses	168 (3.4%)	6±2	5.0- 7.0	148(2%)	5±1	4.0- 6.0	129 (3.2%)	5±1	4.0- 6.0	335 (2.0%)	16±2	15.1- 16.9	110 (0.7%)	14±3	11.4- 16.6	445 (2.7%)	16±3	15.0- 17.0

EC clinical: EC doctors, EC nurses; non-EC clinical: Surgery, Medicine, Paediatrics, Obstetrics and gynaecology, Psychiatry, Family medicine, Clinical research, Anaesthesia, non-EC nurses

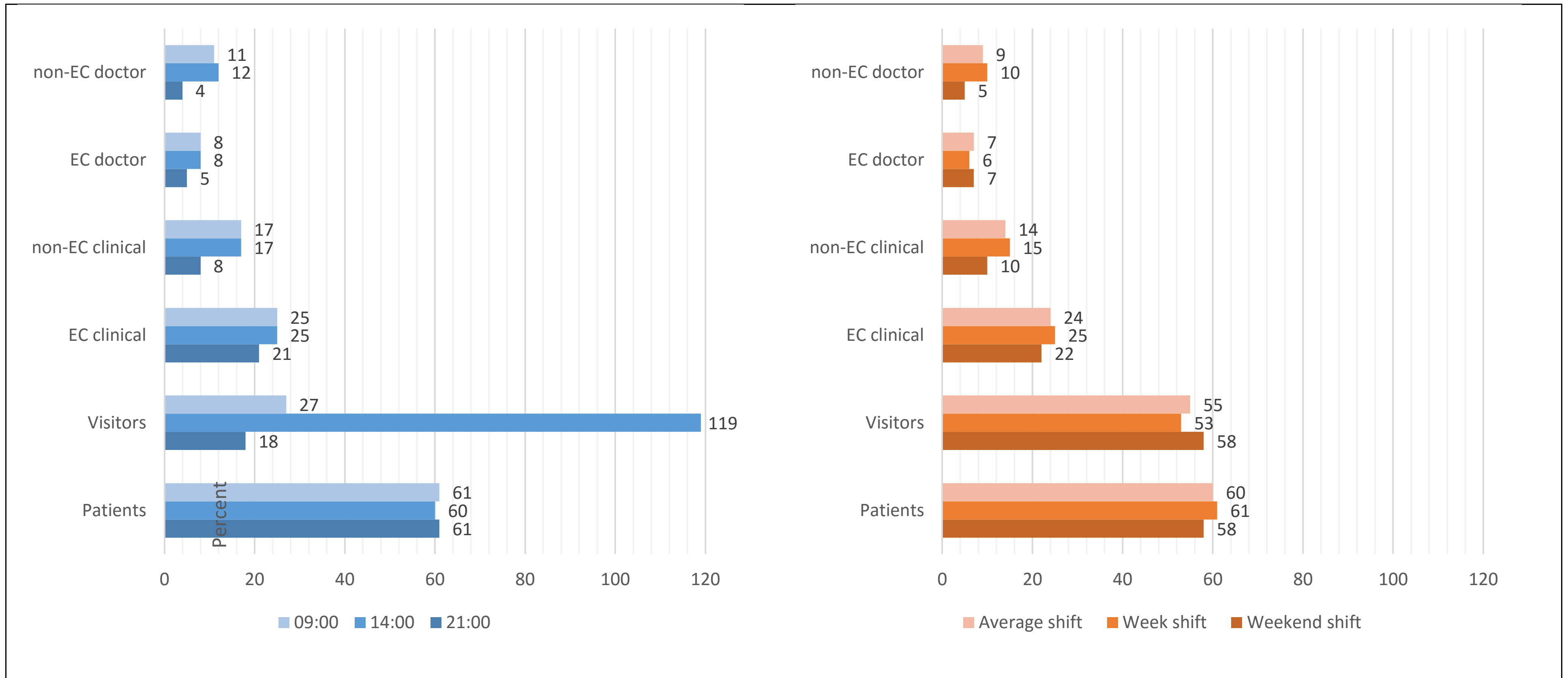

Figure 2. A representation of the differences between the persons occupying the EC for the three daily time-slots and week vs. weekend shifts

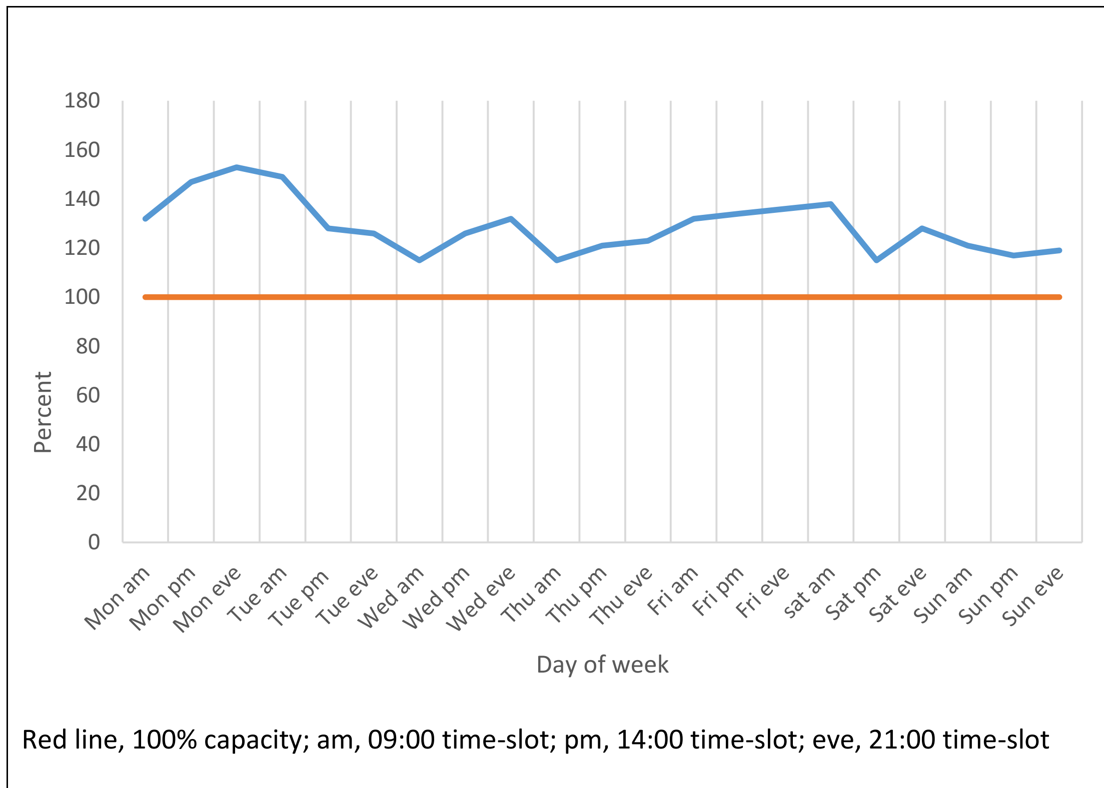

Figure 3. Trend of bed occupancy rate (blue line) in the Emergency Centre averaged out over the study period

Discussion

Staff levels fluctuated predictably with fewer staff at night and on the weekend, though patient numbers remained constant throughout. Non-EC doctors more than doubled on week days compared to week evenings, and did so in significantly greater numbers than EC doctors at the same times. Taking into account in-patient crowding and that non-EC doctors likely attended the EC to attend to referrals and admitted patients not yet on the ward, this finding would suggest that a substantial number of patients in the EC were likewise not EC patients, but admitted patients boarding in the EC, likely due to access block. Paradoxically, the increase in clinical staff could have had a negative effect on efficiency as it would also have increased competition for limited EC resources and workspace. EC nurse numbers remained fairly constant throughout the week, but dipped significantly over weekends. Taking into account the fairly constant number of patients in the EC, nurses were likely to be stretched thin at times between new emergency arrivals and boarding patients. Gilligan, et al. made similar observations in their study (although

with smaller numbers), showing that there was an association between the volume of patients in the EC and other people groups (especially visitors) that contributed to the EC crowd.[14] Essentially this meant that more visitors and staff converged on the EC when there were more patients—in the case of Khayelitsha EC, this convergence was shown to be rather substantial, but mainly on week days—not evenings, or weekends. What is also different in our study is the significant reduction in clinical staff after hours and weekends despite unchanged patient numbers. Taking all of this into account, the effect of a crowd of this magnitude on safety and quality of care would be worrisome.

Surprisingly, visitors made up nearly a third of persons overall in the EC with a significant peak in the afternoons. One explanation for this might be related to the suspected large number of EC boarders. Although clinical staff numbers did not reduce during the busiest visitor times, the huge amount of crowding at this time is likely to have reduced privacy, restricted access to patients and impacted on care. This observation was also commented on by Gilligan, et al., as well as Richards, et al. in his survey on overcrowding of directors of emergency departments in California.[14, 17] Restricting access to visitors, in order to maintain EC flow might be a solution to reduce this number, however, it does open an ethical question regarding patients' right to be visited in hospital. One more concerning finding to note was that there were nearly as many security staff on duty as there were EC doctors. The mere presence of security in that number would suggest a risky work environment, something likely to be exacerbated during significant periods of crowding.

The average occupancy level remained fairly constant, always greater than 100%, which matched reported occupancy rates on ward. Although not directly measured, this finding points to access block as a key culprit. The Australasian College for Emergency Medicine defines access block as a "situation where patients are unable to gain access to appropriate hospital beds within a reasonable amount of time".[18] Occupancy is a simple metric used for measuring crowding in the EC as it allows assessment of crowding in real time.[11, 12] Forster, et al. suggested that there is an association between the level of hospital occupancy and length of stay for patients who require an inpatient bed.[19] Our study did not consider length of stay, which would have been helpful. It would therefore be disingenuous to suggest that the causes for access block is not multi-factorial. One basic factor of a successful hospital is a smooth patient flow, that is, movement of patients

through the service transitions.[20] Poor and weak patient flow through the network of queue creates poor patient care situations, patient discontent and unsatisfied staff.[20] Most research concurs that the magnitude of EC crowding is a reflection of a whole system flow pathology.[21, 22, 23, 24] In other words, crowding in an EC exists not because of an EC problem but because of a hospital problem. Although not directly measured, it is evident that there is likely to be a systemic patient flow problem that requires further attention; non-EC doctors more than doubled during the day on week shifts, in significantly more numbers than EC doctors, suggesting that many of the patients in the EC were likely to be boarded. With a finite number of spaces available in the EC and the larger number of patients negotiating these, it is likely that many did not end up in a space conducive to their state of health.

There were a number of limitations to this study. Patient arrivals, acuity, length of stay, and downstream system barriers that affects boarding and EC-related crowding were not directly explored. It was not the intended purpose of the study; however, including these would have made the study stronger. Given that the nearly all systems and data available to describe flow locally are fairly rudimentary, paper-based and lacking an electronic record, significant resources would be required locally to evaluate these in any detail. This would likely be exacerbated in even less resourced ECs such as those North of the South African border. More work is required to define simple, cost-effective ways to track crowding within settings that lack adequate resources to collect and maintain the data to do so. Identifying details of the crowd allowed a simple overview of the problem, along with the discussed inferences, at an achievable budget. The lack of randomisation in selecting the four-week data collection period was a limitation, but was simply not practical given time-lines and resource restrictions. The study team acknowledges the effect this might have had on generalisability and bias as it pertains to seasonal differences and normal variation. As a preliminary study in a single, high- patient turnover setting, the findings may therefore not reliably reflect the situations in other, local public hospital ECs. Anecdotally, however, most local public hospitals struggle with similar large patient numbers. Ours is one of the first studies to document crowding locally and is likely to present findings that many local public ECs would be able to relate to. Patients were not specifically identified as EC or non-EC. This would have required a different level of consent to allow access to patients' medical records. Unfortunately the study team did not have the resources for such a design. Although non-EC

nurse numbers are provided as part of the sample, it is unlikely that they contributed to anything but crowding because non-EC nurses were mainly found to be loitering in the EC during data collection. Their presence in the sample may give an inaccurate perspective of the number of clinically engaged nurses. Occupancy was calculated as bed and clinical chair spaces inside the EC. Chairs in the minor ailments area waiting room were not included, but the three examination stretchers in this area were. These three beds, as well as the bed in the procedure room, are technically high turn- over spaces which patients do not occupy for extended periods of time (for instance, boarding). Not including these four beds would have resulted in an even higher occupancy rate.

Conclusion

Describing the people that contribute to the EC crowd in a low- to middle income country may provide a uniform template for defining the contribution to the EC crowd where resources to perform a more detailed analysis are lacking. For our setting this can be summarised around three focal points: staff levels fluctuate predictably with less staff at night and over the weekend but with patient numbers remaining constant; visitors make up a substantial number of persons overall in the EC; and EC occupancy rates tend to be high, matching reported occupancy rates on the wards. We concur with Gilligan, et al. that there is an association between the volume of patients and other people groups that contribute to the EC crowd. Replication of this study in other low resourced centres may provide a valuable insight into the make-up of the African EC crowd. As a descriptive study findings should be carefully interpreted. Further research is recommended on EC crowding, specifically more research of flow and access block metrics that can be tracked at a relatively low cost, qualitative research of the perceptions of staff, patients and visitors regarding safety and quality, and the effect of crowding on quality of care and patient safety.

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Chapter 4: Supplemental methodology and findings

4.1 Introduction

This chapter is divided into two sections: supplemental methodology, and results. The supplemental methodology section summarises the general study methods, including study design, study setting, characteristics of the study population, recruitment and enrolment, research procedures and data collection methods. It also describes the data analysis and explains how these were analysed. Finally, it reviews ethical considerations. Care was taken not to duplicate contents already described in Chapter 3 unless required for context.

4.2 Methods

4.2.1 Study design

A descriptive study design plays a vital role in medical research since it is often the first scientific method in new areas of investigation; it prompts a direction for more rigorous studies; and it gives a clear, specific, and measurable definition of the condition in question.[1,2] This study design answers the five basic W-questions: who, what, why, when, where as well as a sixth one: and so what? [3]

Descriptive studies are used for hypotheses generation.[3] According to Last, this study design is "concerned with and designed only to describe the existing distribution of variables, without regard to causal or other hypotheses".[4] For example, a published article by Silverman revealed that observant clinicians noted that babies who were kept in incubators with high oxygen concentration developed blindness. This finding led to analytical studies, then a randomised controlled trial confirmed the association.[5] For this study, the methodology served as the basis of the audit tool for evaluation of local EC crowding. Given our lack of substantial resources or access to an electronic record that tracks patient flow, we were interested in focussing to instead describe a snapshot of the size of the crowd and what it is made up of. In the absence of electronic record keeping, documenting attendance timings, etc. a way had to be found that will both provide sufficient data to describe the study aim and match the resources available. This resulted in the current study aim: to describe the people that contribute to the EC crowd at Khayelitsha hospital at 09:00, 14:00 and 21:00 every day for four weeks. It was felt that this

approach would provide clues about the nature of crowding in Khayelitsha's EC that might enable stakeholders to develop hypotheses about the cause and perhaps further, focused research. Despite its limitations it would likely also contribute to the sparse knowledge about crowding locally.

Descriptive studies are used to monitor trends for a particular problem.[3] For example, descriptive studies played a major role in documenting the emergence of syphilis epidemics in the Russian Federation.[6, 7] The possibility of using such a design as the basis of a simple audit tool may help hospitals to monitor the local trend of EC crowding. Given the low resources required to duplicate the study, a multicentre approach would be feasible and at the backend enable proper planning of resources and improvement of services.

It was because of these strengths and the lack of existing data that we felt this study design to be appropriate for this thesis. It is worth mentioning that descriptive study design has disadvantages too. An important one regards temporal associations between cause and effect. This temporal association, inferred to be a causal one, could often be false (post hoc ergo propter hoc reasoning). [3, 8] In simple terms, the association between two events in a descriptive study tends to be seen as coincidence and assuming cause would be an incorrect assumption. This study design may also affect generalisability and bias. Finally, excess prevalence due to very long stay cases would also affect the data collection.[3]

4.2.2 Study setting

The study setting is described in Chapter 3.

4.2.3 Characteristics of the study population

Khayelitsha hospital has an estimated catchment population of 391,749. The hospital is a 230-bed facility and has the functional mandate of a district referral hospital. During 2014, the EC managed an estimated 3000 patients on average per month. The EC has five doctors (from a pool of 18) and 15 nurses (from a variable pool that includes locum nurses) per shift. Other EC affiliated staff include paramedics, porters, security, catering, cleaning, and administration staff (personal communication, Dr Sa'ad Lahri 2016/03/21).

4.2.4 Recruitment and enrolment

Apart from patients, all other people groupings identified in the EC formed part of the patient associated population. All persons in the EC at 09:00, 14:00 and 21:00 during the consecutive four-week study period were thus included. Data collection was performed by the principal researcher using a simple tick sheet with a list of predefined categories (see Appendix 1). The principal researcher was identified to staff and patients by wearing a name badge at all times. Collection included a brief introduction (see consent below) to each person before enquiring which pre-defined category they belonged into (the different classifications of people have already been described in Chapter 3). A space to include categories not listed was also available on the tick sheet.

4.2.5 Research procedures and data collection methods

Data were collected as a headcount of patients and the patient associated population (per predefined category) at 09:00, 14:00 and 21:00 every day for four weeks from 15th June 2016. Data capture was started promptly at these times and was completed within two hours. The date, time of commencing and time of ending data capture were captured on the tick sheet. The three time-slots (09:00, 14:00 and 21:00) were selected *a priori* by the study team, in consultation with clinicians in the EC. These times were selected as it was perceived to be the peak time points for EC crowding over the course of an average day. The data collection times took place an hour after shift change and overlapped with ward rounds, visiting times and the early peak of the night shift. This was the same reasoning used in the Gilligan, et al. study.[9]

The data collection plan was devised and discussed with a statistician. Since a four-week data collection was employed by Gilligan, et al. it was felt that this should be replicated at our study site.[9] As this study was meant to be a hypothesis finding study, the research team along with the statistician felt that the four-week data collection period was sufficient in providing an initial snapshot of crowding. The research team noted the limitation this would place on generalisability and bias of results; this has been expanded on in detail in Chapter 5 as part of the discussion.

The route of movement through the EC for data collection was in the following order: triage (including psychiatric area), resuscitation, ambulatory area (asthma), non-ambulatory area

(trolley), procedure room and the paediatric EC area (Figure 4). This helped in avoiding duplication. Given the open plan setting and observational nature of the study some duplication was unavoidable.

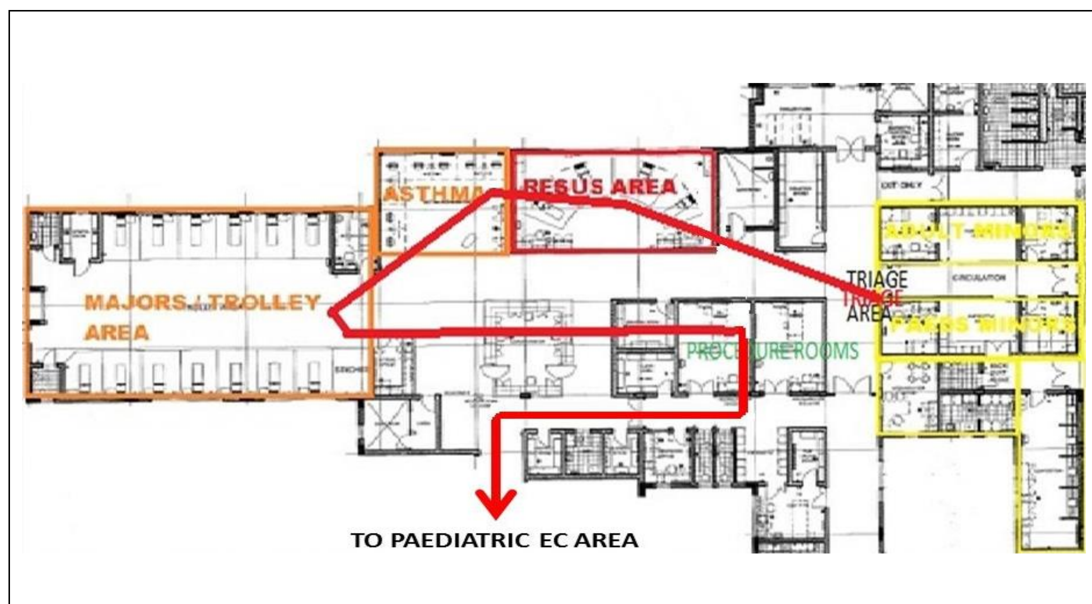

Figure 4. Route through the EC for data collection: triage, resuscitation, ambulatory area (asthma), non-ambulatory area (majors), procedure room and the paediatric EC area

4.2.6 Data management

4.2.6.1 Data safety and monitoring

Data was electronically stored in a password protected file on a password protected work computer at Khayelitsha hospital EC. Identifiable data was not collected; only head counts were taken. In order to do this correctly the principal researcher interacted with patients, visitors and staff. The hard copy data were entered into an Excel Spreadsheet (Microsoft Office, Redmond, USA) directly after collection. Hard copies were then stored in a lockable cupboard to which only the study team have access. Any transfer of data was done using encrypted UCT email. USB storage devices were not used to store or transfer data. Only the study team had access to this data. Data was captured and transposed from the individual files to one aggregated data sheet. The document had three sheets — morning, afternoon, and evening for the different data from the different times of the day. The analysis was then done from there.

4.2.6.2 Data analysis

Data were analysed using Excel (Microsoft Office, Redmond, USA). Different people groups were expressed as proportions with the mean used to describe central tendency, standard deviation to describe spread and the 95% confidence interval to describe precision. Various patients to group ratios (for visitors and staff groups) were calculated to see how these changed over time. These ratios were compared between time-slots using the Chi-Square test (significance was described as a $p < 0.05$). Occupancy was defined as the number of patients per available EC spaces. This was graphically expressed to show change over time.

4.2.7 Ethical considerations

The study was granted ethics approval by the University of Cape Town, Faculty of Health Sciences, Human Research Ethics Committee (HREC REF: 085/2016) and the Western Cape Health Research Committee on behalf of Khayelitsha Hospital Research Committee.

4.3 Additional results

4.3.1 Describing the different categories of people in the EC during the study period

Table 2 presents the different people groups in the EC during the three different time-slots for the 29-day study period (ranked from most commonly present to least commonly present). There were 37, 34 and 27 different categories of people found in the EC during the morning, afternoon and evening shifts respectively.

Table 2. Different categories of people in the EC during the three shifts of the day for entire period

	Morning shift (0900)	**Afternoon shift (1400)**	**Evening shift (2100)**
1	Patient	Patient	Patient
2	Visitor	Visitor	Visitor
3	EC doctor	EC doctor	EC doctor
4	Non-EC doctor: Surgery	Non-EC doctor: Surgery	Non-EC doctor: Surgery
5	Medicine	Medicine	Medicine
6	Paediatrics	Paediatrics	Paediatrics
7	Obstetrics & Gynaecology	Obstetrics & Gynaecology	Obstetrics & Gynaecology
8	Psychiatry	Psychiatry	Research

	Morning shift (0900)	Afternoon shift (1400)	Evening shift (2100)
9	Family	Family	Anaesthesia
10	Research	Research	EC Nurse
11	Anaesthesia	Anaesthesia	Non- EC Nurse
12	EC Nurse	EC Nurse	Prehospital staff
13	Non- EC Nurse	Non- EC Nurse	Healthcare student: Medical
14	Prehospital staff	Prehospital staff	Prehospital staff
15	Healthcare student: Medical	Healthcare student: Medical	Other staff: Security
16	Prehospital	Prehospital	Porter
17	Security	Security	Cleaning
18	Porter	Porter	Admin
19	Cleaning	Cleaning	CSSD
20	Catering	Catering	Pharmacy
21	Admin	Admin	Radiography
22	Dietician	Dietician	Laboratory
23	CSSD	CSSD	Linen
24	Store	Store	House-keeping
25	Pharmacy	Pharmacy	Undertaker
26	Research assistant	Research assistant	Transport
27	Radiography	Radiography	Forensic pathology
28	Laboratory	Laboratory	
29	Linen	Linen	
30	House-keeping	House-keeping	
31	Undertaker	Undertaker	
32	Physiotherapy	Physiotherapy	
33	Maintenance	Maintenance	
34	Transport	Transport	
35	Occupational therapy		
36	Psychology		

	Morning shift (0900)	Afternoon shift (1400)	Evening shift (2100)
37	Forensic pathology		

4.3.2 Describing the number of different categories of people over study period

People categories in the EC during the study period are represented in Figure 5. Smaller categories were grouped into a single group labelled the ancillary group. Patients (5231, 32%) and visitors (4752, 29%) were the largest groups, and notably the proportion of visitors was nearly equal to that of patients. Non-EC nurses (445, 3%) and healthcare students (357, 2%) were the smallest group.

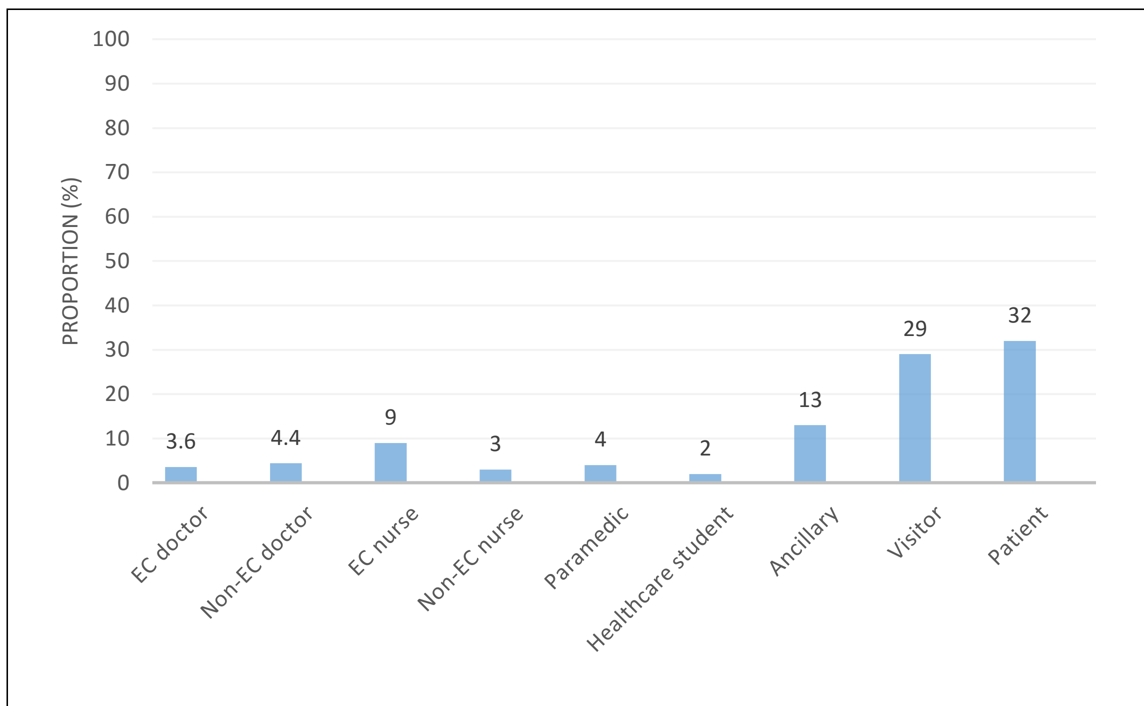

Figure 5. Proportion of selected main categories of people in the EC

Regarding EC staff: there were more EC nurses (n=1488 (72%), mean=52, 17/shift) compared to EC doctors (n=586 (28%), mean=21, 7/shift). Regarding non-EC staff: There were more non-EC nurses (n=445 (38%), mean=15, 5/shift) followed by non-EC doctors: medicine (n=368 (31%) mean=13, 4/shift), surgery (n=147 (12%), mean=5, 2/shift), obstetrics and gynaecology (n=93

(8%), mean=3, 1/shift), and paediatrics (n=62 (5%), mean=2, ±1/shift). Smaller specialties made up the rest of the clinical non-EC group (n=63 (5%), mean=2 ±1/shift). Overall, there were twice as much EC clinical staff as non-EC clinical staff with the highest number of clinical staff on Wednesdays. Medicine made up half of all non-EC doctors, 368 (50%); followed by surgery, 147 (20%); obstetrics and gynaecology, 93 (13%); paediatrics, 62 (8%); psychiatry, 27 (4%); research clinicians, 26 (3%); anaesthesia, 7 (1%), and family medicine, 3 (<1%).

Figure 6 shows the comparison between EC clinical versus non-EC clinical staff. Overall there were more EC clinical staff (n= 2074 (64%), mean=73, 24/shift) than non-EC clinical staff (n=1178 (36%) mean=40, 13/shift). Security, 532 (25%), and cleaning services staff, 533 (25%), made up half of all ancillary staff in the EC during the study period.

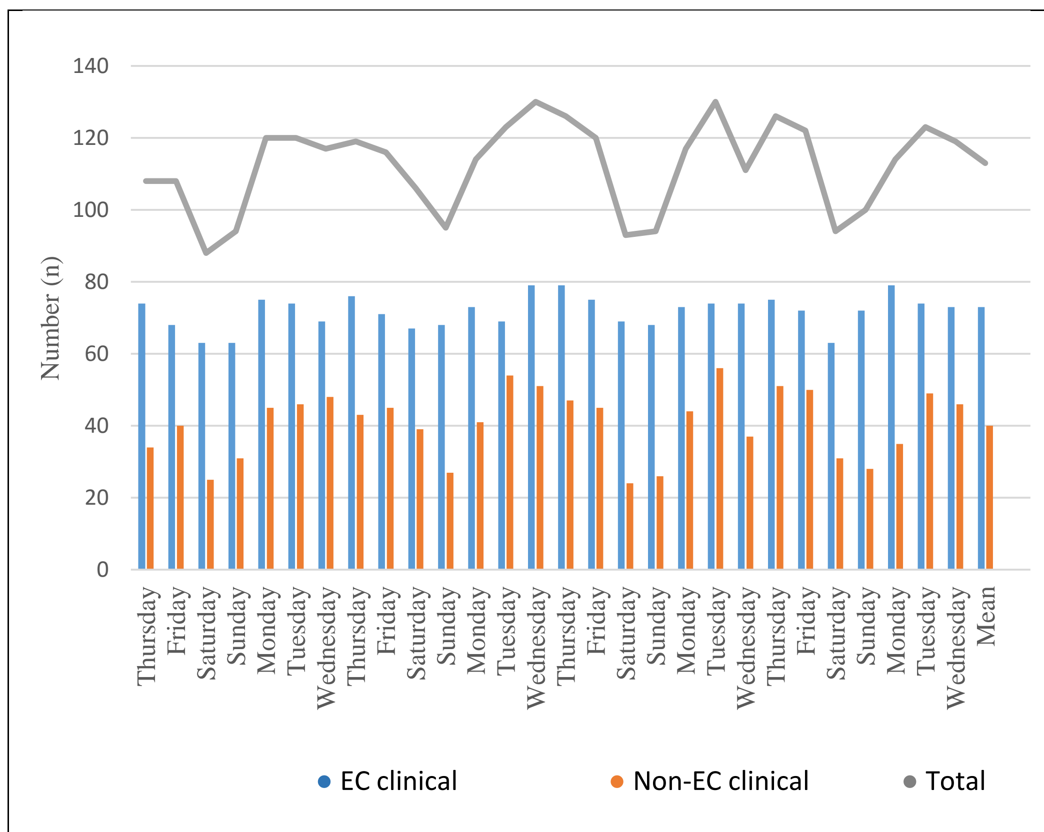

Figure 6. Comparing the numbers of EC clinical versus non-EC clinical staff (the trend line indicates the sum of EC and non-EC clinical staff)

The EC was most crowded on Wednesdays (n= 2761, 17%), followed by Mondays (n=2395, 15%), Fridays (n=2344, 14%), Tuesdays (n=2339, 14%), Thursdays (n=2291, 14%), Saturdays (n=2175, 13%), and Sundays (n=2048, 13%)

4.3.3 Describing the EC occupancy rate over the study period

Table 3 shows the average number of patients and bed occupancy levels per day of week during the three different shifts.

Table 3. Average number of patients and bed occupancy levels per day of week during the three different shifts

	Morning collection (09:00)			**Afternoon collection (14:00)**			**Evening collection (21:00)**		
Day of week	**No. of patients**	**No. of beds**	**Occupancy rate (%)**	**No. of patients**	**No. of beds**	**Occupancy rate (%)**	**No. of patients**	**No. of beds**	**Occupancy rate (%)**
Monday	62	47	132	69	47	147	72	47	154
Tuesday	70	47	149	60	47	128	59	47	126
Wednesday	54	47	115	59	47	126	62	47	132
Thursday	54	47	115	57	47	122	58	47	124
Friday	62	47	132	63	47	135	64	47	137
Saturday	65	47	139	54	47	115	60	47	128
Sunday	57	47	122	55	47	118	56	47	120
Mean	61	47	130	60	47	128	62	47	132

Notably, Mondays had the highest number of patients with an average of 68 patients per day. As a result, the average bed occupancy level was 144%. On the other hand, Sundays had the least number of patients with an average of 56 patients per day and an average bed occupancy level of 130%.

4.4.1 Describing the patient to non-patient and staff ratios over the study period

Table 4 shows the important patient to non-patient and staff ratios for the three-different time- slots on any given day, weekdays, weekend days and a standard day. Only visitors to patients' ratio for the three-different time-slots showed a significant difference, with a p-value < 0.001. There were no significant differences for the rest of people groups compared.

Table 4. Patient to non-patient ratio, and EC to non-EC ratio (n in parenthesis)

People group	Ratio at 09:00	Ratio at 14:00	Ratio at 21:00	Weekdays	Weekends	Ratio for day
Visitors	2.25 (61/27) 13 /30 patients	0.50 (60/119) 60 /30 patients	3.39 (61/18) 9 /30 patients	*1.14 (183/160)* *26 /30 patients*	*1.00 (173/173)* *30 /30 patients*	1.09 (180/164) 27 /30 patients
Staff (all groups)	0.76 (61/80) 39 /30 patients	0.72 (60/83) 42 /30 patients	1.09 (61/56) 28 /30 patients	0.79 (183/231) 38 /30 patients	0.95 (173/182) 32 /30 patients	0.83 (180/218) 36 /30 patients
Staff (all clinical)	1.45 (61/42) 21 /30 patients	1.43 (60/42) 21 /30 patients	2.10 (61/29) 14 /30 patients	1.54 (183/119) 20 /30 patients	1.80 (173/96) 17 /30 patients	1.59 (180/113) 19 /30 patients
EC clinical	2.44 (61/25) 12 /30 patients	2.40 (60/25) 13 /30 patients	2.90 (61/21) 10 /30 patients	2.47 (183/74) 12 /30 patients	2.58 (173/67) 12 /30 patients	2.55 (180/72) 12 /30 patients
EC doctor	7.62 (61/8) 4 /30 patients	7.50 (60/8) 4 /30 patients	12.20 (61/5) 3 /30 patients	8.31 (183/22) 4 /30 patients	10.17 (173/17) 3 /30 patients	9.00 (180/20) 3 /30 patients
non-EC clinical	3.59 (61/17) 8 /30 patients	3.53 (60/17) 9 /30 patients	7.63 (61/8) 4 /30 patients	4.06 (183/45) 7 /30 patients	5.97(173/29) 5 /30 patients	4.39 (180/41) 7 /30 patients
non-EC doctor	5.55 (61/11) 5 /30 patients	5.00 (60/12) 6 /30 patients	15.25 (61/4) 2 /30 patients	6.31(183/29) 5 /30 patients	11.53 (173/15) 3 /30 patients	6.92 (180/26) 4 /30 patients
EC clinical	0.68 (17/25) 7 /5 non-EC clinical	0.68 (17/25) 7 /5 non-EC clinical	0.38 (8/21) 13 /5 non-EC clinical	0.61(45/74) 8 /5 non-EC clinical	0.43 (29/67) 12 /5 non-EC clinical	0.57 (41/72) 9 /5 non-EC clinical
EC doctor	1.38 (11/8) 4 /5 non-EC doctors	1.50 (12/8) 3 /5 non-EC doctors	0.80 (4/5) 6 /5 non-EC doctors	1.32 (29/22) 4 /5 non-EC doctors	0.88 (15/17) 6 /5 non-EC doctors	1.30 (26/20) 4 /5 non-EC doctors

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Chapter 5: Discussion

5.1 Describing the different categories of people in the EC

Gilligan et al. identified in their study an association between the volume of patients and other people groups and that this contributed to the EC crowd.[1] In essence what this means is that more people accompanying or dealing with patients (i.e. the patient associated population) converged at the EC in what appears to be a response to patient numbers in the EC. It can naturally be expected for ECs to receive different people groups because of the diverse needs of patients who are admitted from there; however, we observed that the EC became fairly crowded with these different people groups. Thirty-seven different people groups were identified during the study period with larger representations from groups present in the morning and afternoon than in the evening shifts. This finding was fairly consistent with the exception of weekends when non-EC groups reduced substantially (despite patient numbers remaining constant). It was fairly clear simply looking at the people groups and numbers in the groups at different times, that evenings and weekends were likely associated with a more risky care-environment than mornings and afternoons during the week when more staff were converging in the EC.

5.2 Describing the number of different categories of people in the EC

We found that patients' relatives/visitors made up nearly a third of all persons overall in the EC; with a significant peak in the afternoons between 15h00-16h00 (as this time coincided with the hospital's visiting hours). At times the volume of patients and visitors in the EC would have made safe care fairly difficult and likely have infringed on a patient's right to privacy. The most likely explanation for this would relate to a large number of EC boarders. As discussed in the Chapter 2, EC boarding is associated with a number of safety compromises (including an increase in mortality and morbidity). This finding was also highlighted by Gilligan but to a lesser extent.[1] Elsewhere, similar observations were made in the USA and the Netherlands, where surveys of hospital management members were conducted to assess the problem of crowding.[3,4] Restricting access to patients' relatives/visitors, might be required to provide a safe working environment, however, this is very difficult to implement locally where there is no system (electronic or paper-based) that tracks patients in the EC from where security screens visitors during visiting times. Effectively the EC is treated as another ward with the key difference

between the EC and a ward being that the latter has a finite number of beds to fill. It does open an ethical question over a patients' right to be visited in hospital versus a patient's right to safe care. In this case the former is not in opposition to the latter.

The fact that more non-EC doctors were found in the EC than EC doctors are an interesting finding. The latter are employed to work in the EC but the former would only come to the EC to see referred (or likely boarded) patients – their numbers were simply too high to suggest that attendance was only related to referrals. Non-EC doctors halved during evenings in the week and over weekends, and did so in significantly greater numbers than EC doctors at the same time. As previously mentioned patient numbers remained very stable throughout. What the data do not tell us are which proportion of the numbers are EC patients and which are non-EC patients (boarders). An increase in non-EC doctors would result in direct competition with EC doctors for limited EC resources such as examination space, consumables and access to limited computer terminals for checking results, etc. On the other hand the drop in attendance from non-EC doctors during evenings and over weekends may have simply passed the care burden of boarded patients to EC doctors during these times. Both situations would likely affect efficiency of EC staff. As with increased visitor numbers, variable non-EC doctor numbers needs closer review. Given the high burden from infectious disease (such as HIV and tuberculosis) locally, doctors from medicine made up half of all non-EC doctors. Derlet et al. published an article relating EC crowding to patient safety issues. In a case study in the article, the EC was crowded and patients were treated in the hallways. A senior emergency doctor on duty took the risk of assessing a patient in the crowded hallway with shortness of breath, where it was difficult to render the optimum of care. After requesting for several diagnostic tests including an ECG, the doctor did not personally interpret the ECG because of the crowded ward. The patient was stabilised, treated, and discharged; only to return two days later with cardiac arrest. The patient died after a failed resuscitation. An autopsy report revealed acute pulmonary emboli. The doctor eventually lost his license to practice.[5] This sad event testifies how unsafe the EC could be when it is crowded. It also tells us the effect of a crowded EC on the on-site clinical staff such as the EP. This adverse incident could impact the nursing staff who work in the EC as well.

Non-EC accounted for the highest number of non-EC clinical staff. The unexpected high numbers of non-EC nurses were likely due to the fact that the medical and surgical overnight wards are

found just adjacent to the EC. Anecdotally these nurses were reported during data collection to loiter in the main acute area contributing to the crowd but not patient care. Although not directly studied, it is possible that non-EC nurses (from a non-crowded ward) may reduce the efficiency of EC nurses (from a crowded EC) by distracting EC nurses from their work. This needs further study.[6] The arguments above summarises similar observations made by Gilligan et al. in their study.1 In another qualitative study conducted in an Ireland EC about the experiences of patients' relatives there, they described the EC as crowded, and resembling a disaster zone. They also described the environment as dirty and lacking resources. The patients and their relatives suggested measures such as, the reduction of waiting times, improved communication systems, improved security, and a better privacy within the department.[7]

A considerable number of healthcare students (medical, nursing, and prehospital) were found in the EC during the study. Healthcare students contributed to the crowd more in the mornings than afternoons and evenings. A recent qualitative study that evaluated the impact of EC crowding on a training programme revealed that fewer procedures were undertaken when the department was crowded, affecting students' ability to learn.[8] This was not specifically studied, however. Security and cleaning services made up around half of all ancillary staff, followed by porters, and administrative clerks. It was concerning to note that there were nearly as many security staff on duty as there were EC doctors. The mere presence of security in that number would suggest a predictable hostile work environment, something likely to be exacerbated during significant periods of crowding. Given the large numbers of security and cleaning services required, it would be interesting to find out if patient relatives will also describe the study setting as a disaster zone.[7]

5.3 Describing the EC occupancy rate over the study period

Emergency Centre occupancy levels forecast EC crowding in real-time.[9, 10] It is fairly simple to calculate and as discussed in the literature review likely gives as much information and more complex scores. We discovered in our study that Mondays had the highest occupancy level of 144% whiles Sundays had the lowest of 130%. Interestingly occupancy never dipped under 100% and as described in Chapter 3, these numbers are very likely an under-estimate given that non-admission beds in the procedure room and minors area were included in the calculation. As already discussed, factors that could influence hospital occupancy levels such as the ability to

transfer patients that have been boarded in the EC to hospital beds include availability of beds, local service structure, ancillary services, nursing staff and nursing ratios.[11] Among all the possible causes of EC crowding, inadequate inpatient bed capacity appears to adversely impact on throughput processes, including: registration, triage, room placement, initial provider evaluation, diagnostics and treatment.[12] These factors are reported to be the major contributors to EC crowding as it results in access block.[13, 14, 15] The Australasian College for Emergency Medicine defines access block as a "situation where patients are unable to gain access to appropriate hospital beds within a reasonable amount of time".[16] The result of course requires only a change of a few words: "situation where patients are unable to gain access to appropriate *care* within a reasonable amount of time". Hillier et al. posited that a higher hospital occupancy level leads to EC crowding and this has a negative effect on throughput.[17] This means that plausibly there is an association between hospital occupancy and EC occupancy levels. So, a high EC occupancy level is a reflection of the level of occupancy in the hospital inpatient wards such as medicine, surgery, operating theatres, high care and intensive care units. It is worth noting that high occupancy level hospitals may not necessarily treat more patients, but rather due to prolong length of stay, become inefficient and treat less overall.[11] The problem of EC crowding is a global challenge yet given the lack of local observational data very little is known about access block. Our study did not investigate the causes of EC crowding, so cannot attribute access block as the main factor. It does make a case that crowding exists and that this is likely due to access block. The latter requires further study.

5.4 Describing the patient non-patient ratio over the study period

It comes as no surprise that the physician and nursing staffing ratio are likely to influence the crowd in the EC.[13] According to the World Health Organization (WHO) estimates in 2015, the density of the health care workforce per 10000 population for the Africa region was a mere three physicians compared to 32 in the European region; for nurses the density was 12 compared to 80 in the Europe region.[18] It is not challenging to link this to crowding in local health care facilities. In Gilligan's study, there were more staff during the morning with a ratio of 25 staff per 3a 0 patients; a ratio of 15 staff per 30 patients in the afternoon and 17 staff per 30 patients in the evening.[1] Gilligan does not clarify exactly what staff are made up of, but it is assumed that it refers to clinical staff. We found this ratio to be 21 staff per 30 patients during 09:00 time-slot,

21 staff per 30 patients during the 14:00 time-slot and 14 staff per 30 patients during the 21:00 time-slot; giving an overall average of 19 staff per 30 patients. These numbers do not differ much from Gilligan's, and likely this is so as the causes for the problem do not differ that much either – access block. As can be expected given the WHO figures, absolute numbers in our study was far lower than Gilligan's again raising a patient safety concern.

5.5 Describing the EC staff non-EC staff ratio during these times over the study period

There were fewer non-EC doctors on evening shifts and weekends shifts but not significantly so. What is important about this is the substantial reduction in clinical staff after hours and weekends despite unchanged patient numbers (and likely patient requirements). Patient safety concerns have already been discussed but should be raised here as well.

5.6 Limitations

Understanding the flow and load of African ECs was useful as a motivation in performing the study to a high standard. Data collection was done prospectively which helped to improve the quality thereof. It was only noticed in hindsight that other categories such as EC patients versus boarded patients would have proven useful in analysis. This would have required consent from patients as their folders would have had to be consulted to get accurate information. Again, providing information on waiting room patients would have clarified the actual inflow of patients over 24 hours (waiting room occupancy). It is strongly recommended that these be included in any similar future studies. This was just a single centre study and we made use of a non-randomised sample of just four weeks. Describing an EC crowding for only four weeks may not give a full picture of what happens there on a day to day basis for the rest of the year, given the fact that various factors could influence numbers, including predictable surge periods. This will undoubtedly affect generalisability and bias of the study. Still, the findings were useful as a preliminary study as it revealed the level of information that can be gained as well as future inclusions when replicated locally. The findings would no doubt be familiar to clinicians working in local public sector ECs. Possibly double counting some persons for any given shift could not be ruled out (especially during the early days of the study). We do believe this was kept to a minimum by using a single data collector and using a dedicated data collection path.

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Chapter 6: Conclusion and recommendations

6.1 Conclusions

A recent study undertaken by Gilligan et al. showed that crowding of patients in the EC correlated with an increase in other people groups such as visitors or patients' relatives and staff from inpatient teams.[1] As a study that utilised no advanced system resourced to conduct we felt that this would be useful within our own setting to describe the EC associated crowd. This thesis described a number of interesting findings. We observed that different categories of people converged in the EC at all times to perform a variety of duties because of a higher than capacity volume of patients, and in doing so contributing to crowding. The EC was more crowded in the morning and during the week and less crowded in the evening and over weekends although this was mainly due to staff fluctuations and not patient numbers (the latter remained remarkably stable). Visitors accompanying patients made up a large portion of all persons in the EC, but especially in the afternoons when visitor number rose to nearly 120 persons (about a third of all persons in the EC. We also observed that non-EC doctors more than doubled on weekdays compared to week evenings, and did so in significantly greater numbers than EC doctors at the same time. The nursing staff working in the EC remained fairly constant throughout the week, but then dipped significantly over weekends. The response to crowding of this magnitude on safety and quality of care is worrisome. The average occupancy rate remained fairly constant, and always greater than 100%. Even though our study did not consider inpatient length of stay, this finding suggests that access block is very likely. Again, at the very least it flags a substantial patient safety concern. Subtyping EC patients as boarders or under treatment by EC team would have been feasible and provide a relatively easy way of suggesting cause for the crowding. This would have added great value to the findings.

Describing the people that contribute to the EC crowd in a low-to-middle income setting may provide a uniform template in defining EC crowding. In our study, we can conclude that the main findings were: staff levels fluctuated predictably with less staff at night and over weekends whilst patients remained constant. Although clinical staff numbers did not reduce during the busiest visitor times (afternoons), given the huge amount of crowding at this time care was likely to

suffer. Occupancy matched reported occupancy rates on ward suggesting an institution-wide problem.

6.2 Recommendations

We recommend the following:

1. Further research should be conducted to determine the extent of EC boarding. It is recommended that this be included in an re-evaluation using this study's methodology
2. Further research is required to determine the appropriate balance between patient safety, patient privacy and visitor numbers in the EC. We would also recommend qualitative studies to determine patients and their relatives' perspectives of EC crowding
3. Further research is required to determine the ideal balance between patient safety, local resource utilization and non-EC doctors in the EC. We would also recommend research into how staff efficiency is affected during crowding. We would also recommend qualitative studies to determine both EC staff and non-EC staff's perspectives of EC crowding
4. We would recommend research into the specific causes of access block at Khayelitsha hospital so that this can be addressed to alleviate the service pressure on the EC and improve patient safety and quality of care. There are fairly simple, researched measures to be instituted to address access block which is described in the literature review. The hospital should consider piloting some of these and monitoring the effect on crowding to determine which is more effective.
5. In the interests of patient safety we would recommend that Khayelitsha hospital institute an escalation policy agreed to by all local stakeholders.
6. We recommend repeating this study (with the suggested amendments) following these interventions.
7. We also recommend repeating this study locally (with the suggested amendments) within the region to get a perspective of the burden of crowding to inform local policy and resource allocation.

References

1. Gilligan P, Joseph D, Bartlett M, et al. The ‘who are all these people?’ study. Emerg Med J. 2015; 32(2):109-11.

Appendices

Appendix 1: Data collection and consent sheet

Date: Time started: Time completed: Area (circle): Triage | Psych | Resus | Asthma | Trolleys | Procedure | Paeds

Consent prompt

- *Hello, I am conducting a study that involves counting the persons in the emergency centre*
- *Can you confirm whether you are a patient, visitor or a staff member?*
- If a staff member: *To which category (from list) do you belong?*

Category	Count (tick once for each subject)	Subtotal (add ticks for subtotal)
Patients		
Visitors		
Doctors		
EC		
Non-EC:		
Surgery		
Medicine		
Paediatrics		
O & G		
Others		

Category	Count (tick once for each subject)	Subtotal (add ticks for subtotal)
Nurses:		
EC		
Non-EC		
Prehospital staff/ Paramedics		
Healthcare student (medical)		
Healthcare student (nursing)		
Healthcare student (prehospital)		
Security Staff		
Porters		
Catering Staff		
Administrative Staff		
Other (specify):		
Other (specify):		
Other (specify):		
Other (specify):		
Other (specify):		
Other (specify):		
Other (specify):		