

**Admission trends at Red Cross War Memorial Children's Hospital,
Cape Town: 2004 to 2013**

By

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PREAMBLE

DECLARATION

I, Yumnah Isaacs (ISCYUM002), hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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*To my parents,
For your endless support and encouragement*

Abstract

Background: Hospital database research has the potential to provide useful insights into health systems functioning, population health, clinical conditions and epidemiological trends thereof. This type of research is routinely done in countries that have large national hospital databases where results are usually extrapolated to the national population. South Africa does not have a national hospital database, but individual healthcare institutions, such as the Red Cross War Memorial Children's Hospital (RCCH) in Cape Town, collects routine patient data in a computerised database that if tapped should yield valuable information about child health of the catchment population as well as of the functioning of that health institution.

Methods: Selected data from the RCCH database were converted into spreadsheet format and then exported into a statistical programme, Stata. Variables included patient demographic details, ICD-10 diagnostic codes, length of hospital stay and outcomes at discharge. Stata was used to clean and code the data and perform basic descriptive analyses of contained variables. Medians and interquartile ranges described numerical variables. Frequencies, proportions and percentages described categorical variables. Appropriate tests of statistical significance were performed where applicable. Admission and mortality trends were analysed across a decade and common conditions were explored.

Findings and Conclusions: Overall admissions to RCCH increased by 9.3% across a decade while the number of new patients decreased by 8.6%, indicating an increase in readmissions. In-patient mortality decreased consistently across a decade despite an increase in admissions, which suggests an improvement in quality of care. The median ages of admissions and deaths increased across the decade, which correlates with less HIV and improved management thereof. Infections remain the commonest causes of in-hospital mortality. Admissions and mortality for diarrhoea and pneumonia displayed a consistent decline across 6 years corresponding with the introduction of new vaccines; however, diarrhoea and lower respiratory tract illness remained the commonest causes of medical admission. Injuries were the commonest reason for surgical admissions. Computerised hospital databases contain useful information for healthcare research.

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And lastly, thank you to my supervisor and co-supervisor for their valuable input and guidance throughout my work on this project.

List of Abbreviations and Acronyms

AIDS	Acquired Immunodeficiency Syndrome
ANC	African National Congress
ANOVA	analysis of variance
ART	antiretroviral therapy
CCS	Clinical Classifications Software
COPD	chronic obstructive pulmonary disease
DCST	District Clinical Specialist Team
DHS	District Health System
DHIS	District Health Information System
EPI	Expanded Programme on Immunisation
HCUP	Healthcare Cost and Utilization Project
HES	Hospital Episode Statistics
HIV	human immunodeficiency virus
ICU	intensive care unit
IMCI	Integrated Management of Childhood Illness
IMR	infant mortality rate
IQR	interquartile range
KID	Kids' Inpatient Database
LMIC	low- and/or middle-income countries
LOS	length of stay
LRTI	lower respiratory tract illness
MAR	missing at random
MCAR	missing completely at random
MDG	Millennium Development Goal
MMR	maternal mortality ratio
MNAR	missing not at random
MTCT	mother-to-child transmission
NAGI	National Advisory Group on Immunisation
NCD	non-communicable disease
NHI	National Health Insurance
NHS	National Health Service

NIS Nationwide Inpatient Sample
NMR neonatal mortality rate
PCV pneumococcal conjugate vaccine
PHC primary health care
PMTCT prevention of mother-to-child transmission
RCCH Red Cross War Memorial Children's Hospital
SA South Africa
TB tuberculosis
U5MR under-5 mortality rate
UN United Nations
URTI upper respiratory tract illness
US United States
WHO World Health Organization

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Part I

RESEARCH PROTOCOL

Admission trends at Red Cross War Memorial Children's Hospital, Cape Town: 2004 – 2013

1. Protocol Summary

The health of a country's children is a stark reflection of the state of that country's affairs. The level of social stability, the state of living conditions, the extent of poverty, the performance of the education system and the accessibility and quality of healthcare services for children all impact on their well-being. Various indicators of child health and well-being have been described, but few are routinely monitored and reported (1). Essential to improving the health and decreasing the mortality of children is the strengthening of health systems that provide for their health needs. A reliable and effective health information system is key for this objective.

Red Cross War Memorial Children's Hospital (RCCH) has a relatively untapped clinical database that has been accumulating admissions and discharge data since 2001. The objective of this project is to explore and describe the trends in admissions, disease patterns and mortality across a decade at RCCH. The results of this study are anticipated to be of use to clinical and administrative departments at RCCH and to ultimately assist in enhancing the services provided by this healthcare institution.

2. Introduction

2.1 Background

Clinical databases, the maintenance of which have become a universal component of hospital administrative tasks, comprise a valuable resource of information that, if properly utilised, has the potential to yield important additions to knowledge that can inform clinical, administrative and policy decision-making, and thus serve to improve overall quality of care (2).

The World Health Organization (WHO) has identified an effective health information system as one of six integral building blocks necessary for health system strengthening; but despite this designation, there remains a dearth of published studies on health services and systems (3).

Data from hospital discharge repositories have been used to study the impact of specific infectious diseases. A series of studies at Chris Hani Baragwanath hospital in Soweto, Johannesburg, used discharge data from general paediatric wards spanning the 1990's until 2011 to describe the course the HIV/AIDS pandemic took in South Africa. The first studies, from 1992 to 1997, captured the upsurge in HIV prevalence and described the pandemic's impact on admission rates, mortality rates (4) and on disease profiles (5). A later study captured the deceleration in impetus of the epidemic, suggested to be due to improvements in prevention of mother-to-child transmission (PMTCT) rates, anti-retroviral treatment (ART) coverage and new vaccines on the Expanded Programme on Immunisation (EPI) schedule (6).

After an outbreak of measles in the United States (US) in 1989/1990, a study was conducted to assess the outbreak's impact using discharge data from all hospitals in the state of California, which accounted for half of the country's cases. Besides describing the epidemiology of the outbreak, an analysis was performed to assess the health impact and financial cost of the outbreak for citizens and the public health system (7).

These studies no doubt highlighted significant public health concerns and provided valuable information for crucial health policy planning and interventions.

A study of paediatric admissions data from hospitals in the Oxford region, England, sought to examine admission trends for the period 1975 to 1985. This was in

response to a general trend of rising hospital admission that seemed particularly marked in paediatrics. The main finding was an increase of 73% in hospital admissions despite a fall of 13% in the studied population. The analysis showed that the main cause for the increase in admissions was a lowered threshold for unplanned admissions largely from emergency units (8).

A later English study was performed to assess the impact that a re-structuring at primary care level had had on paediatric hospital admission rates for the period 1997 to 2006. Only unplanned, short stay admissions (less than two days) were analysed, as this was considered to be the group of patients that would best reflect a change at primary care level. The findings of an increase in short stay admissions of up to 41% supported the notion that restricted access at primary care level was not an effective practice (9).

After major reforms in the Canadian healthcare system that promoted a shift towards community-based treatment, a large nationwide study was performed to assess the impact these reforms had on hospital use for children. Discharge data were analysed for the periods 1986/7 and 1996/7. Medical and surgical admission rates were analysed and the top ten conditions for each discipline were listed and compared between the two periods. By the end of that decade, the combined list saw asthma (a medical diagnosis) overtaking chronic disease of tonsils and adenoids (a surgical condition) as the major disorder responsible for hospitalisation. The main findings of a halving of the hospitalisation rate and a decrease in the average length of stay by the end of this period supported the notion that enacted health reforms had been effective (10).

Towards a proposal for a shift in healthcare similar to that achieved by the Canadian model, a nationally representative sample of paediatric discharges from hospitals in the US were analysed to identify admissions that could have benefited from care in an observation unit instead of hospital admission. These admissions were patients that had spent one night or less in hospital between 1993 and 2003. The findings showed a steady increase in these “high-turnover” admissions over the period and constituted 30% of all admissions towards the end of the decade. These findings supported the authors’ bid for a new healthcare model that made provision for care in observation units, thereby avoiding unnecessary hospital admissions (11).

The studies described above all demonstrate the usefulness and broad application of clinical information contained in hospital databases. For health systems research, such clinical data would be utilised to evaluate indicators of hospital function and quality of medical care. Research from an epidemiological perspective, however, would be more concerned with the study of disease patterns or trends and the outcomes thereof (12).

Despite the obvious usefulness of database information, several authors have advised caution with interpretation of such data, as high error rates have been observed to occur throughout the recording and coding processes (2,12-14). Error rates have been observed to vary considerably between hospitals and tend to vary between the different types of variables encoded. Researchers are therefore encouraged to make use of appropriate statistical tests to measure the accuracy of their data (14).

2.2 Justification

Red Cross War Memorial Children's Hospital (RCCH) in Cape Town, South Africa, is a government teaching hospital with a 283-bed capacity that offers tertiary and quaternary services to children under the age of 13 years. It is the main paediatric referral hospital for the southern half of the Western Cape but also treats patients from all over South Africa and occasionally from other African countries.

Since 2001, admission and discharge data on all patients have been stored in a computerised database referred to as "Clinicom". This database is generally assumed to be more consistent and reliable from 2004 onward.¹

Apart from being used for monthly administrative audits, no formal analysis has been attempted of the information contained in Clinicom to date. Research that has emanated from RCCH tends to focus on specific clinical topics such as poisoning (15), head injuries (16,17) and Kaposi's sarcoma (18), and more recently on the 2009/2010 measles epidemic (19). One prospective study on causes of death at RCCH was performed before Clinicom became fully operational (20).

¹ Information imparted by Tessa Strauss, data manager at the Informatics department of RCCH.

An analysis of the information in this database is envisaged to be of use to clinicians and management at RCCH and ultimately to contribute towards the strengthening of this healthcare institution.

2.3 Objectives

Primary

1. To provide a basic description of admissions to RCCH for the period 2004-2013, including absolute numbers of admissions per year, number of admissions per ward for each year, age and sex distribution of annual admissions and average length of hospital stay per year. Trends in hospital admissions and length of stay through the decade will be examined.
2. To describe and compare the commonest diagnoses encountered at RCCH across a decade and to examine any trends in disease patterns during this period.
3. To describe mortality trends for the period 2004-2013.

Secondary

1. To describe the influence of HIV as a co-morbid condition on the findings from the primary analysis.

3. Methods

3.1 Study Design and Measurement

Study Design

The Clinicom database at RCCH, which contains routinely collected information on all in-patients from 2001 up until the present, comprises two separate data repositories as follows: 1) an admissions dataset that holds information about all hospital admissions and internal transfers, and 2) a separations dataset that consists of information abstracted from discharge summary forms and hospital folders upon discharge from hospital. This study is a descriptive analysis of the data contained in both repositories.

Population

The study population comprises all patients admitted to RCCH between January 2004 and December 2013. Patients admitted with general medical and surgical conditions are largely from the central health districts of Cape Town. More specialised paediatric services are available to a wider patient population that occasionally extends beyond the borders of the province and country.

Variables list

Data capturers are responsible for entering data into the Clinicom database. Admissions data are abstracted from admissions and transfer forms that are usually completed by ward clerks. Discharge data are abstracted from discharge summaries that are usually completed by junior doctors upon patient discharge from the ward.

The main variables for analysis from the datasets are as follows:

Table 1.1 List and definition of variables

Variable	Scale/Options
Admissions Data	
Ward Name	Categorical – Nominal 16 different medical and surgical wards
Activity Date	Date of admission or transfer
Ipstat transfer index	Categorical – binary (A=admit or T=transfer)
Patient date of birth	Numerical
Patient home postal code	Numerical – discrete
Primary diagnosis code	ICD-10 classification used
Subsidiary diagnosis code	ICD-10
Secondary diagnosis codes	ICD-10 – up to 10 secondary diagnoses per patient
Specialty	Categorical – nominal (up to 62 options)
Sex	Categorical – Male, female or indeterminate

Separations Data	
Discharge ward	Categorical – nominal
Length of stay	Numerical – discrete
Patient age	Numerical - discrete
Activity date	Date at which discharged
Outcome at discharge	Categorical – nominal (18 options)

3.2 Issues of Validity and Reliability

Validity and Reliability of data

The recorded data contained in hospital databases has long been recognised to be prone to error (2,12-14,21). Multiple points along the patient pathway through the health system have been identified as potential sources of error that are likely to impact on both the accuracy and reliability of the documented information. From the point of entry into the hospital where circumstances related to the patients' physical state, ability and willingness to impart information; their sojourn in the wards where factors such as the experience of the attending clinician and the utility of diagnostic tests ordered come into play; to the eventual diagnostic label that is recorded in the patient's file that usually gets encoded by data capturers with an error rate ranging from 17.1 to 76.9 percent; errors occur invariably that may affect the outcomes of interest in database research (12).

There are various statistical methods available to assess and quantify the amount of error contained in these repositories, which will assist in the interpretation of research findings. However, such an undertaking is beyond the scope of this project but is being pursued in a parallel project based on the RCCH Clinicom data.

Missing Data

Large clinical databases, especially those that record emergency and critical care patient information, are notorious for containing significant amounts of missing data (22,23), which can potentially introduce bias into research findings if not appropriately dealt with (2). Missing data can usually be ignored if it is missing

completely at random (MCAR) or missing at random (MAR), as in both scenarios missingness is not associated with the value of the unobserved variable (22,23) and is therefore unlikely to result in any bias. However, if it involves a large chunk of the data it could have undesirable consequences from a power point of view (24). The real challenge occurs when data is missing not at random (MNAR). This type of missing data will result in bias if it is ignored during analysis (24). There are several basic statistical methods that can be used to explore and categorise the pattern of missing data. If one does conclude that the missing data is MNAR, robust techniques are available for incorporating those cases with unobserved variables into the main data corpus for more reliable estimates (22-24). This type of analysis, however, is beyond the scope of this study.

Generalisability

Due to the wide variability in geographical origin of the RCCH patient population, it would be difficult to make any substantive inferences about the source population based on this study's findings. The study population is not sufficiently homogenous or representative of a well-defined population to satisfy conditions for generalisability. However, patients admitted to the general medical or surgical wards or acute care facilities mostly reside in the Cape metropole districts the hospital services.

4. Data Management and Analysis Plan

The data will be transferred from the Clinicom database in spreadsheet format. The spreadsheet file will be exported into a statistical software programme, Stata version 12.0 (Stata Corporation, USA). All analyses will be performed using Stata. The data will initially be cleaned and recoded as necessary. Cleaning and re-checking will continue throughout the analysis process. All variables will be checked for missing data and where necessary further exploratory tests such as correlations and chi-square tests will be computed to assess the pattern of missingness.

4.1 Objective 1

The findings from the analysis of this objective will be summarised in the first table. Absolute numbers will present annual admissions. Absolute numbers and percentages will be used to describe the ward breakdown of admissions. The proportion of males and females comprising the admissions for each year will be computed. The appropriate measure of central tendency will be used to describe the average annual length of stay and age distribution of patients. The chi-square test for trend will be used to examine changes in any categorical variables of interest through the passage of time. Wilcoxon sum rank test or the t-test will be used to test for significant changes in continuous variables. Ninety-five percent confidence intervals will be computed for all point estimates.

4.2 Objective 2

Diagnoses will be ranked in descending order for each year and for each discipline (medical and surgical). The top ten diagnoses for each discipline will be listed in a table illustrating these findings at the start and end of the decade. The common childhood diseases of pneumonia and diarrhoea will be explored to detect any interesting trends over time.

4.3 Objective 3

The proportion of admissions resulting in mortality will be calculated for each year of the study period, in total and by ward, and will be tabulated and graphically presented. An analysis of causes of death will be carried out.

4.4 Objective 4

All secondary diagnosis variables will be searched for diagnostic codes indicating HIV disease. The findings will be tabulated and the Chi-square test for trend will be used to determine the significance of any observed trends.

5. Ethical Considerations

Clinicom at RCCH is a large and expanding database that requires valuable time and resources to maintain. To do justice to this asset would be to make full use of its potential to provide relevant information for health systems strengthening. Information used in this way would thus benefit the institution as well as the broader community that it serves. This study will be the first to attempt such an analysis of this database.

With specific reference to the ethical principles outlined in the Declaration of Helsinki (25), the following considerations apply:

- In order to protect the privacy of subjects listed in the database, all identifying information such as names and street addresses will be omitted from the working dataset. Additionally, access to the data files used in this study will be password protected and accessible only to the investigators and data management administrative staff at RCCH. Anonymity and confidentiality will thus be maintained. Folder numbers remain in the working dataset, but will not be linked to patient identifiers and will not be used in the analysis.
- As the database consists of routinely collected patient information that forms a part of standard hospital practice, and as no patient identifiers will be necessary for the analysis, obtaining individual patient consent is not deemed applicable in this particular study.
- The envisioned benefits of this study are not anticipated to be direct.
- There is no foreseeable harm for participants.
- Permission to use the Clinicom database for the purposes of this study has been granted by the Hospital Research Review Committee of RCCH, pending ethics approval.
- The main investigator has no affiliations or sources of funding that may influence the outcomes of this study. The study will be undertaken primarily for the fulfillment of degree requirements.

6. Reporting to Stakeholders

The results of this study are eagerly awaited by clinical and management personnel at RCCH. A summary of the main findings will be prepared and disseminated to them in print as well as a formal presentation. A summary of the findings will also be submitted to the Department of Health of the Western Cape. The findings are expected to be of use for clinical and management purposes and perhaps even at a policy-making level. These stakeholders will then be able to further disseminate the findings, if they so wish, via their respective portals. Lastly, a manuscript of the study will be submitted to an appropriate peer-reviewed medical journal, most likely the South African Medical Journal, for broader dissemination of the study's findings.

7. Logistics

Table 1.2 Logistics timetable

Task	Duration
Data cleaning and exploration	3 months
Data analysis and write-up	3 months
Preparation of manuscript	3 months

8. Budget

The costs for this project are anticipated to be minimal, consisting mainly of printing and stationery expenses, which will be covered by the principal investigator.

References

1. Saloojee H. Monitoring child health. In: Dawes A, Bray R, van der Merwe A, editors. *Monitoring child well-being. A South African rights-based approach*. Cape Town: HSRC Press; 2007. p. 93-109.
2. Safran C, Chute CG. Exploration and exploitation of clinical databases. *Int J Bio-med Comput* 1995; 39(1):151-156.
3. World Health Organization. Everybody's business: strengthening health systems to improve health outcomes: WHO's framework for action. WHO 2007. Available at <http://www.who.int/healthsystems/strategy/en/> (accessed November 2014)
4. Zwi K, Pettifor J, Soderlund N, Meyers T. HIV infection and in-hospital mortality at an academic hospital in South Africa. *Arch Dis Child* 2000; 83:227-230.
5. Zwi KJ, Pettifor JM, Soderlund N. Paediatric hospital admissions at a South African urban regional hospital: the impact of HIV, 1992-1997. *Ann Trop Paed* 1999; 19:135-142.
6. Meyers T, Dramowski A, Schneider H, Gardiner N, Kuhn L, Moore D. Changes in paediatric HIV-related hospital admissions and mortality in Soweto, South Africa 1996-2011: light at the end of the tunnel? *J Acquir Immune Defic Syndr* 2012; 60(5): 503-510.
7. Chavez GF, Ellis AA. Pediatric hospital admissions for measles. Lessons from the 1990 epidemic. *West J Med* 1996; 165(1-2): 20-25.
8. Hill AM. Trends in paediatric medical admissions. *Br Med J* 1989; 298:1479-1483.
9. Saxena S, Bottle A, Gilbert R, Sharland M. Increasing Short-Stay Unplanned Hospital Admissions among Children in England; Time Trends Analysis '97-'06. *PLoS ONE* 2009; 4(10): 1-6.

10. Connors C, Millar WJ. Changes in children's hospital use. *Statistics Canada, Health Reports* 1999; 11(2): 9-20.
11. Macy ML, Stanley RM, Lozon MM, Sasson C, Gebremariam A, Davis MM. Trends in high-turnover stays among children hospitalized in the United States, 1993-2003. *Pediatrics* 2009; 123(3): 996-1002.
12. O'Malley KJ, Cook KF, Price MD, Wildes KR, Hurdle JF, Ashton CM. Measuring diagnoses: ICD code accuracy. *Health Services Research* 2005; 40(5): 1620-1639.
13. Green J, Wintfield N. How accurate are hospital discharge data for evaluating effectiveness of care? *Med Care* 1993; 31(8): 719-731.
14. Peabody JW, Luck J, Jain S, Bertenthal D, Glassman P. Assessing the accuracy of administrative data in health information systems. *Med Care* 2004; 42:1066-1072.
15. Balme K, Roberts JC, Glasstone M, Curling L, Mann MD. The changing trends of childhood poisoning at a tertiary children's hospital in South Africa. *S Afr Med J* 2012; 102:142-146.
16. Lalloo R, van As AB. Profile of children with head injuries treated at the trauma unit of Red Cross War Memorial Children's Hospital, 1991-2001. *S Afr Med J* 2004; 94(7): 544-546.
17. Schrieff LE, Thomas KGF, Dollman AK, Rohlwink UK, Figaji AA. Demographic profile of severe traumatic brain injury admissions to Red Cross War Memorial Children's Hospital, 2006-2011. *S Afr Med J* 2013; 103(9): 616-620.
18. Cairncross LL, Davidson A, Millar AJW, Pillay K. Kaposi sarcoma in children with HIV: a clinical series from Red Cross Children's Hospital. *J Ped Surg* 2009; 44:373-376.

19. Le Roux DM, Le Roux SM, Nutall JJ, Ely BS. South African measles outbreak 2009-2010 as experienced by a paediatric hospital. *S Afr Med J* 2012; 102(9): 760-764.
20. Grandin W, Westwood T, Lagerdien K, King MS. Deaths at Red Cross Children's Hospital, Cape Town 1999 - 2003 - a study of death notification forms. *S Afr Med J* 2006; 96(9): 964-968.
21. Corn RF. Quality control of hospital discharge data. *Med Care* 1980; 18(4): 416-426.
22. Joseph L, Belisle P, Tamim H, Sampalis JS. Selection bias found in interpreting analyses with missing data for the prehospital index for trauma. *J Clin Epidemiol* 2004; 57:147-153.
23. Henry AJ, Hevelone ND, Lipsitz S, Nguyen LL. Comparative methods for handling missing data in large databases. *J Vasc Surg* 2013; 58(5): 1353-1359.
24. Osborne JW. Chapter Six: Dealing with missing or incomplete data. Debunking the myth of emptiness. Best practices in data cleaning: A complete guide to everything you need to do before and after collecting your data Thousand Oaks, CA: SAGE publications; 2012. p. 105-138.
25. World Medical Association (WMA), Declaration of Helsinki. Ethical principles of medical research involving human subjects. <http://www.wma.net/en/30publications/10policies/b3/>

Part II

LITERATURE REVIEW

Literature Review

1. Introduction

Child health has gained much attention worldwide over the past few decades particularly after the United Nations' resolution to address issues of child health and mortality. South Africa came under the spotlight as a country struggling to cope with several health-related challenges, foremost among them being increasing child mortality. An additional challenge arose with attempts to monitor child mortality indices as population vital registration was incomplete and of uncertain quality. Nevertheless, other sources of available population-level data, such as from surveys, were used to estimate the under-5 mortality rate, a sensitive indicator of national child health. Key to making substantial improvements in child health is regular monitoring and research around child health indicators, at national and local level, from available and preferably affordable data sources.

The aim of this literature review is to gain some perspective on the prevailing status of child health in South Africa, including insights into the main causes of morbidity and mortality. In addition, a brief examination of the South African public healthcare system will be made to provide a context in which the results of healthcare research can be interpreted. Lastly, a review of studies that have analysed paediatric hospital databases will be made to explore the types of analyses and enquiries commonly made in that type of research to inform the methodology for this Master's project.

1.1 Literature Search Strategy

The following search terms were used to query the search engines 'Pubmed' and 'Google Scholar' for literature pertaining to paediatric database studies: (paediatric OR pediatric OR child*) AND (mortality OR morbidity OR trends OR admission* OR discharge OR separation) AND (hospital OR database). Different combinations of these search terms were also used to make separate enquiries of these search engines.

2. Child health in South Africa

2.1 Background

In 2000, the United Nations (UN) General Assembly, in its quest to eradicate poverty and promote development and human rights, set eight Millennium Development Goals (MDGs) for several key indicators of social need that were resolved to be achieved by signatory States by 2015 (1). Each of those goals related either directly or indirectly to child health (2). The under-5 mortality rate (U5MR), which MDG 4 committed to decrease by two-thirds by 2015 from the designated baseline of 1990, is regarded as a sensitive indicator of child well-being, because it not only reflects the coverage of child health services aimed at child survival, but also nutritional status and other social determinants of a child's health and well-being (2)

The Countdown to 2015 collaboration, in their 2008 and 2010 reports to *the Lancet*, identified South Africa as one of 68 priority countries for MDG 4 and MDG 5 (a reduction in maternal mortality by three-quarters). South Africa was one of only a few countries that displayed a worrying trend of not simply inadequate progress, but an actual reversal in progress towards achieving MDG 4 (3,4). The 2008 report set South Africa's baseline U5MR at 60 deaths per 1000 live births for 1990 and 69 deaths per 1000 live births for 2006, demonstrating that the country was struggling to implement effective health policy, no doubt partly due to the HIV/AIDS crisis that unfolded over that period (2,3). Despite some doubt about the reliability of data used to calculate the U5MR – death registration data was incomplete but also improved during this period – calculations of the U5MR performed by other agencies from varying data sources demonstrated a similar trend, albeit with some variability between the estimates (2,5).

The 2010 report, however, showed the beginnings of a positive downward trend in the U5MR – 56², 73 and 67 deaths per 1000 live births for 1990, 2000 and 2008 respectively. This reversal in trend, however, was not deemed sufficient to be considered progress towards the 2015 goal (4). The South African government though, in their 2013 country report, expressed more optimism in achieving MDG 4

² Methods for calculating estimates were reported as improved and refined for the 2010 report.

on time, based on the Statistics South Africa estimate of 53 deaths per 1000 live births for 2011 (6). This positive trend was considered to be largely due to the success of the prevention of mother-to-child transmission (PMTCT) campaign and to the introduction of new rotavirus and pneumococcus vaccines onto the Expanded Programme on Immunisation (EPI) schedule (6).

2.2 Causes of childhood mortality and morbidity

A study by Sanders et al, which explored the causes of childhood mortality in South Africa for the period 2000 to 2005, reported that after HIV/AIDS (responsible for 35 % of under-5 deaths), neonatal causes of death accounted for 30% of mortality in children under the age of five (2). A later study of child mortality using 2007 data, estimated that 21.9% of under-5 deaths were in neonates but that the infant mortality rate (IMR) up until that point had been largely static in the country (5). A study that used data from the period 2006 - 2011 reported that neonatal deaths accounted for about a third of all under-5 deaths with the neonatal mortality rate (NMR) remaining largely unchanged for that period as well (7). The variability in estimates is not surprising when data sources for health indicators in South Africa differ widely in terms of completeness and quality (2,5,8). Nevertheless, it is clear that neonatal mortality is a significant contributor to the U5MR and has to be prioritised if crucial gains towards improving early childhood outcomes are to be realised.

Neonatal mortality is inextricably linked to maternal mortality (3,4). South Africa was identified as a priority country for its high maternal mortality rate (MMR) in 2008 (3). Insufficient progress was made in reducing maternal mortality by 2013 (6) despite several commitments by government to address the high MMR and NMR through policies that promote access to and expansion of maternal, neonatal and child services, PMTCT and exclusive breastfeeding (7). Even with the widespread availability of basic obstetric and neonatal care packages at facilities that are well utilised by expectant mothers, outcomes fell short of expectations (9). An analysis of this paradoxical state of affairs revealed that a large part of the problem was sub-standard implementation of those care packages by attending staff as well as poor monitoring of performance (10). Accordingly, an essential step towards improving child health outcomes is the regular monitoring of performance using facility-level data, which should increase accountability and competence (10). This is in line with

the recommendation of the Health Metrics Network of the World Health Organization (WHO) for investment in administrative databases at health facilities as part of strengthening national health information systems (11).

Outside of the neonatal period, the commonest causes of under-5 mortality in South Africa, from death notification data for 2007, were reported to be due to diarrhoea (almost a quarter of deaths), respiratory infections, malnutrition and tuberculosis (TB) (5). This differed somewhat from in-hospital causes of mortality for 2007, which were listed in order of magnitude to be due to pneumonia, septicaemia, acute diarrhoea, TB and pneumocystis pneumonia (PCP). HIV/AIDS as an underlying cause is poorly recorded in such data, but for that period was estimated to be associated with at least half of all deaths in that age group (5). Child mortality audits for 2011 demonstrated a continued preponderance of infectious causes of under-5 mortality with the top five causes of death due to respiratory infections (29%), diarrhoea (21%), sepsis (16%), TB (7%) and meningitis (6.6%) (7). Once again, half of all deaths were associated with HIV, while 60% of children who died had evidence of malnutrition (7). Poor nutrition, like HIV infection, weakens immune function, thus increasing susceptibility to respiratory, diarrhoeal and other infections (2). The South African government has made significant strides in addressing this burden and recently celebrated the success of the PMTCT campaign in achieving a reduction in the mother-to-child transmission (MTCT) rate to 2.7% in 2011(6,12). In addition, in spite of the huge cost to the national budget, the government heeded the advice of the National Advisory Group on Immunisation (NAGI) and introduced the rotavirus and pneumococcus vaccines into the EPI programme in 2009 (13). Subsequent studies of the public health impact and effectiveness of these vaccines have demonstrated benefit in those vaccinated as well as an overall reduction in hospitalisation and mortality from diarrhoea and pneumonia since the introduction of these new vaccines (14-16). A major challenge that remains for the South African government to address if sustained improvements in child health are to be achieved is the huge problem of increasing poverty, inequality and food insecurity that are major determinants of child health outcomes and access to healthcare (2,7).

3. A brief history of the South African healthcare system

3.1 Pre – apartheid era (1652 – 1948)

In colonial South Africa, the discovery of vast mineral resources in the second half of the nineteenth century intensified the demand for cheap black labour (1). Miners, who mostly hailed from the poor South African homelands, endured squalid living conditions on the mines that were conducive to the spread of TB and other diseases. This disruption in family life is also regarded as an important cause of many social ills today. TB was spread to the homelands with the return of these migrant labourers, and soon spiraled out of control in conditions that favoured dissemination. Poverty-related diseases flourished in the homelands where primary health care (PHC) was almost non-existent and curative services, supplied largely by missionary hospitals, struggled to cope with healthcare demands (17).

In 1940, commissioned by the British led Union government, a pioneering team of medical professionals set out to establish the first “community-oriented primary health care” unit at Pholela in rural Kwazulu Natal (18,19). This fascinating and visionary endeavour is hailed as the earliest attempt to establish primary health care that was recognised only 30-odd years later, at Alma Ata, as the best healthcare model for achieving “better health for all” in an increasingly unequal world (20). The Pholela project held great promise for providing an effective model of healthcare and was to be duplicated at various sites around the country with the establishment of a National Health Service, a comprehensive health system that was envisioned to provide coverage for all sectors of South African society (18).

3.2 Apartheid Era (1948 – 1994)

This promising endeavour was thwarted when the National Party ascended to power in 1948, a rule in which such egalitarian policies were not welcome (18). Instead, the National Party instituted segregationist policies that culminated in the eventual formation of 14 separate, racially defined, inequitably funded health ministries that were ineffective at fulfilling their mandates (18,21).

The National Party, through specific legislation, encouraged the proliferation of the private healthcare sector. This two-tier system of public and private healthcare, which continues to flourish in South Africa, has contributed much to the persisting and worsening inequalities in healthcare in the country today. The private sector absorbs more and more of the health resources of the country, while catering to a largely constant minority of less than 20 percent of the population (17,18, 21- 24). A recent study on healthcare access in South Africa concluded that sectors of society that have the greatest need for healthcare, namely those that are poor, black or from rural areas, experience the greatest barriers to healthcare access. A critical contributor to this disparity is the private health sector, which with its continually escalating user fees effectively obstructs more than 80 percent of the population from accessing quality healthcare (25). This two-tier system is thus considered a remnant of the racist policies of the past, where economic status has simply become the proxy for racial discrimination (24).

3.3 Post – apartheid era (1994 onward)

The new democratically elected African National Congress (ANC)-led government of 1994 inherited a fragmented and ailing healthcare system that required extensive restructuring to meet the health needs of the population. A central National Department of Health with nine provincial departments of health replaced the disconnected 14 health ministries of the past (17). The health plan of the new government espoused the ideals of primary health care and set out to achieve this through the district health system (DHS), which was envisaged to make PHC services more accessible to the general population – eventually at no cost to the user (17). Massive redistribution of resources were needed to achieve this objective; redistribution occurred between provinces as well as from tertiary to primary care settings in order to limit the costs involved in this overhaul, and to allow a more equitable distribution of limited resources (23).

The new government passed legislation to address pressing health issues such as those related to abortion (1996), smoking (1999) and mental health (2001) amongst others, which were lauded as successful by many (17,24,26). Mass immunisation

campaigns were embarked upon to eradicate outbreaks of measles and polio; hundreds of new clinics were constructed or revamped; an essential drugs list was compiled to ensure the uniform availability of important drugs; standardised treatment guidelines were composed to assist in the equitable provision of healthcare; the government built houses for the poor, improved access to water, sanitation and electricity and initiated an ambitious social grant programme that has no doubt improved the lot of many (17,26). But despite all these worthy efforts the health outcomes of the nation deteriorated (18).

3.4 Challenges faced and that lie ahead

One of the greatest challenges faced by the new democratic government was HIV/AIDS. The first cases of HIV in South Africa were detected in the early 1980s, predominantly within the homosexual community. Towards the end of the decade, the virus started spreading within the general population, especially among those involved in the migrant labour system (27). The Nationalist government did little to address this public health concern as it was then regarded as a disease peculiar to Blacks. At the time of change in political dispensation, the epidemic entered an upsurge and the fragile healthcare system started to buckle over the following years, inundated with patients afflicted by this novel disease as well as from massive migration of people from rural areas to cities and peri-urban centres (21,24). At a time in the epidemic when the need for decisive action was most crucial, the new government failed to assign the problem the priority it deserved and entered an obstructive phase of AIDS “denialism” that proved disastrous for the health of the country. Important opportunities to contain the epidemic and save hundreds of thousands of lives were wasted (27). Child and adult mortality rates increased and worrying decreases in average lifespans were observed that was almost entirely due to HIV/AIDS (26).

The HIV epidemic was accompanied by a rise in TB incidence and particularly resistant strains started to emerge that added another level of complexity to efforts to contain it. From the early 2000’s, after much pressure on government by advocacy groups, more realistic policies such as the National Strategic Plan were enacted for the control of these infectious diseases (27,28). By 2013, HIV prevalence

was on the decline; close to 80% of those eligible for anti-retroviral therapy (ART) was receiving it, and TB cure rates had consistently improved (29).

In addition to the heavy burden of HIV/AIDS on the public healthcare system, further strain is caused by a burgeoning epidemic of non-communicable diseases (NCDs), high rates of injuries related to violence and accidents, and elevated levels of perinatal and maternal mortality (10,30,31). Despite the negative effect on young adult mortality by HIV/AIDS, the demographic shift towards an aging population that is associated with a health transition defined by an increase in non-communicable diseases is developing (18,30). Rates of cardiovascular disorders, diabetes, cancer and other chronic non-communicable diseases are on the rise especially among the rural and urban poor, which does not bode well for a public health system that has not yet been able to integrate the management of chronic infectious diseases and chronic NCDs at primary care facilities (30).

3.5 The way forward

Several authors see the strengthening of the DHS as essential to the overall improvement of health outcomes in the country. The DHS, which is the cornerstone of primary health care in the country, has failed to deliver to its full potential. Poor leadership and rigidity in policy implementation has led to unimpressive health outcomes, inefficiency and poor management of human resources (17,26,32,33). In addition, there is also a chronic shortage of skilled health professionals in the public sector as most are absorbed by the private sector or emigrate, making it difficult to fill PHC posts, particularly those outside of urban centres (17). The DHS needs strong leadership that can act independently and innovatively in response to local health issues, that can boost staff morale, and that can increase accountability and competence in healthcare delivery (17,33). And key to achieving this is with enhanced monitoring and evaluation of health systems performance and health outcomes through improved data collection and strengthening of health information systems (32). An integral step towards improving health service function in preparation for the National Health Insurance (NHI) – South Africa's answer to universal access to quality healthcare for all – is the District Clinical Specialist Team (DCST) (34). The DCST would consist of a team of specialists at DHS level that

would ensure the smooth operation and implementation of care packages for maternal, newborn and child health; this should address many of the current inefficiencies inherent in the DHS, especially with regard to women's and child health (34,35). Other important recommendations are for increased government spending on healthcare and health research and for addressing social determinants of health through intersectoral collaboration for investment in the future well being of all South Africans (33,36).

4. Hospital administrative databases in healthcare research

The U5MR is a useful but broad indicator of child health on a national level. McKerrow et al argue that due to the wide variation in social circumstances of children from different provinces and communities in the country, more meaningful change can be effected if child health indicators are disaggregated to a level that is more specific to communities (5). Thus for healthcare services to be more locally-responsive, which is necessary for optimal outcomes, facility-level data should be analysed for insights into mortality and morbidity indicators at that level (5). Hospital administrative databases that contain routinely collected patient information are an important resource for clinical research (37). These databases are regularly mined for epidemiological, medical and health systems research providing valuable information about disease patterns, health outcomes, quality of care and access to care (38,39).

4.1 Summary of Paediatric Hospital Database Studies

In the 1980's, in England, a trend of increasing paediatric admissions was observed that was financially concerning for the National Health Service (NHS). A study was undertaken to investigate this rise in admissions using routinely collected hospital discharge data for the Oxford region (40). The study confirmed a 73% rise in admissions and an 88% increase in the age-standardised admission rate for the study period (1975-1985). During that period admissions for common respiratory and digestive disorders had increased up to six-fold despite a constant population prevalence. Furthermore, the average length of stay was noted to decrease from 2.4 to 1.5 days. This led the author to conclude that the increase in admissions was largely

due to a change in medical practice that involved a lowered threshold for admission to acute paediatric beds (40).

Following restructuring of the NHS, which allowed general practitioners the option not to offer after hours care and which decreased the working hours of junior doctors in emergency departments, a study of English hospital data was undertaken to determine whether restructuring had led to an increase in short-stay (less than two days) unplanned admissions to paediatric wards (41). Admissions data for a 10-year period (1997-2006) were analysed, and trends in total and short-stay unplanned paediatric admissions were examined. In addition, causes of admission were studied by grouping ICD-10 codes into clinically meaningful groups using special clinical classifications software. Unplanned admissions had risen by 22%; short-stay unplanned admissions had increased by 41% while longer admissions decreased by 12%. The findings suggested that restricted access at primary care level and less-experienced staffing in emergency departments had led to an increase in avoidable hospital admissions (41).

The Canadian health care system underwent large-scale restructuring since the 1980's that involved the closure or downscaling of many hospitals (42). The focus moved towards a more cost-effective model of outpatient and community-based care and stricter criteria for hospitalisation. A subsequent study of hospital usage was conducted using a national database of hospital discharges. Discharge rates, length of hospital stay and common conditions were compared over a 10-year period (1986/7-1996/7) and it was found that even with an increase in the child population there was a halving in the hospitalisation rate and decrease in the average length of stay by the end of the decade. Findings on common conditions suggested an increased efficiency in dealing with common disorders in primary care settings (42).

An American study of paediatric hospitalisations sought to determine whether there was a case for healthcare reform within paediatric care (43). A database containing a nationally representative sample of paediatric hospitalisations was used to explore the trend in "high-turnover" admissions – admissions less than two nights – over a decade (1993-2003) that could potentially have avoided admission had care been available in observation units. They found that discharge rates for high-turnover

admissions increased from 25% of admissions to consistently above 30% for the remainder of the decade, while longer hospital stays either remained constant or decreased. Causes for high-turnover admissions were largely for conditions that could easily be treated in observation units avoiding more costly hospitalisation (43).

These studies demonstrate the usefulness of large national hospital databases in providing important insights into the functioning of healthcare systems as well as morbidity patterns in the population (Table 2.1). Other studies have used hospital databases to gain epidemiological insights into specific diseases (Table 2.2).

The 1990 outbreak of measles in America prompted researchers to study the epidemiology of complicated measles cases i.e. those measles cases that required admission to hospital (44). The hospital discharge database for the state of California, where half of the country's cases were recorded, was analysed for information on measles hospitalisations and related demographic details. The majority of admissions occurred in children 1 – 4 years of age for fluid loss or secondary infections with an average length of stay of 4.6 days and a case fatality of 1%. There were significant racial and socio-economic preponderances and as a result the substantial cost of hospitalisation for that outbreak was largely borne by the public health system (44).

In South Africa, at Chris Hani Baragwanath hospital in Soweto, a computerised database of paediatric medical discharges was used to study the impact of HIV on admission profiles and in-hospital mortality during the upsurge of the epidemic from 1992 - 1997 (45,46). During that time HIV prevalence amongst patients increased from 2.9% to 20%; the median age of patients decreased; admissions for pneumonia, gastroenteritis, malnutrition and TB increased while mortality increased by 42% – all due to HIV. HIV-infected children were admitted on average longer than uninfected children and were more likely to be readmitted once discharged. HIV-negative children became less likely to be admitted for infectious diseases, less likely to be malnourished and less likely to die in hospital during this period. These studies captured the devastating impact of HIV/AIDS on child survival in the country. A subsequent study, which partially made use of the hospital discharge database, described a more positive picture with declining mortality in HIV-infected children, increasing CD4 counts and increasing proportions on ART (47).

Also in South Africa, a novel database called Child PIP that contains information about public sector in-hospital deaths of children up to the age of 18 years was pioneered in 2005 and continues to grow with more facilities contributing data over time (48). The data analysed provide valuable insights into the causes and context of child mortality and the quality of healthcare associated with these deaths on a national and provincial level (48). These findings are regularly published in the “Saving Children” report with the latest report covering data submitted by 61% of countrywide facilities and 84% of health facilities in the Western Cape in 2013 (49). Reported findings include in-hospital mortality rates, commonest causes of death, associated HIV status, nutritional profile, care-giver information, length of hospital stay, referral patterns and modifiable factors surrounding each reported death (48-50). As a result, these reports have become essential in providing much needed insights into child mortality and child health to healthcare providers and policy-makers at national, provincial and facility levels (49).

Several database studies from the United States (US) have been recently published that look at specific conditions in the paediatric population (51-60). These studies have been summarised in Table 2.2. The databases most frequently used are the Kids’ inpatient database (KID) and the Nationwide Inpatient Sample (NIS), which forms part of the Healthcare Cost and Utilization Project (HCUP) that collects routine administrative data for each hospital encounter in the country.

A recent English study used routine hospital admissions data to describe hospital admission rates for pertussis across five decades. Age- and sex-standardised rates were calculated, which displayed distinct peaks in 1973 and 1982. Thereafter, incidence rates declined and remained low until the end of the study period with no further epidemics (61).

A study from New Zealand utilised the national hospital discharge database to describe the hospitalisation rate and epidemiology of injuries in children across a decade. Most injuries were found to occur in males, were caused by falls and involved a fracture of the upper limb (62).

Table 2.1 Database studies for healthcare research

Study	Country & years of study	Source of data	Objectives	Methods & Analysis	Findings & Conclusions
Hill A. (1989)	Oxford county, England 1975 - 1985	Routinely collected hospital discharge data	To investigate trends in and reasons for rise in paediatric (0-14 years) hospitalisations	Increase in admissions (proportions, crude and age-adjusted admission rates per 1000 population) Chi-square test for trend Length of stay (LOS) Source of admission Readmission rate per child Ranking of diagnosis	73% increase in total admissions and 88% increase in age-standardised admission rate. Emergency admissions responsible for largest increase predominantly for respiratory disease, digestive disorders and ill-defined conditions. Decreased threshold for admissions from emergency units.
Saxena S, & Bottle A, et al. (2009)	England 1997 - 2006	National computerised database of all NHS hospital admissions i.e. Hospital Episodes Statistics (HES) database	Investigate increases in short-stay unplanned hospital admissions in 0-9 year age group.	Trends in total and short-stay (<2days) unplanned admissions LOS Readmission rate ICD-10 ranking of common conditions	Unplanned admission rates increased by 21.6%; short-stay unplanned admission rates increased by 41%. Overall reduction in LOS. Increase in readmission rates. Above changes due to restructuring at PHC level that resulted in restricted access after hours.

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Connors C & Millar WJ. (1999)	Canada 1986/7 – 1996/7	National computerized database of discharge data i.e. Hospital Morbidity File	Investigate effect of changes in healthcare favouring community-based treatment of common paediatric (1-14 years) conditions.	Hospitalisation rates LOS Ranking of common medical and surgical conditions	47% decrease in hospitalisation rate. Decrease in LOS. Little change in ranking of common conditions. Community-based and outpatient management of common paediatric conditions led to a decrease in hospital usage.
Macy ML & Stanley RM, et al. (2009)	United States (US) 1993 - 2003	Computerised database of a representative sample of national hospital discharges i.e. Nationwide Inpatient Sample (NIS)	Investigate trends in high-turnover (HTO) stays i.e. <2 nights in hospital among children (0-18 years).	Hospitalisation rate per 100 000 population Proportion HTO stays LOS Logistic regression for HTO associations	Decline in hospitalisation rate and LOS. Consistent increase in HTO stays at around 30%. Minimal change in common conditions. Costs for HTO stays borne mostly by State-funded insurance and uninsured. Findings support case for new model of care, especially of HTO cases, in 'observation units' instead of more costly hospitalisation.

Table 2.2 Database studies that focus on specific conditions

Study	Country & years of study	Source of data	Objectives	Methods & Analysis	Findings & Conclusion
Chavez GF & Ellis AA (1996)	California, US 1986 - 1990	State-based computerised database of hospital discharge data	Examine epidemiology and associated hospital costs of 1990 measles epidemic.	Age-specific hospitalisation rates for measles Relative risk for hospitalisation LOS Secondary diagnosis analysis Mortality ratios and associations Costs of hospitalisation	Majority admissions in 1-4 year age group Racial, socio-economic and geographic predisposition apparent. Common complications identified. Case fatality 1% Average LOS 4.6 days. Epidemiology of hospitalized cases described and costs of outbreak calculated.
Zwi KJ & Pettifor JM, et al. (1999)	South Africa 1992-1997	Computerised database of ward discharges of Department of Paediatrics at Chris Hani Bargawanath Hospital, Soweto.	Describe prevalence of and impact of HIV on disease profiles and in-hospital mortality.	Admission trends – absolute numbers and proportion increases. Proportion HIV Median age Common conditions Mortality proportions LOS Chi-square tests, ANOVA and chi-square test for trend where appropriate	Increase in hospital admissions by 23%. Proportion of HIV-infected increased from 2.9% to 20%. Decrease in median age at admission. Increases in pneumonia, gastroenteritis, TB and malnutrition attributable to rising HIV. Deaths increased by 42% due to HIV.

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Zwi K & Pettifor J, et al. (2000)	South Africa 1992-1996	Computerised database of ward discharges of Department of Paediatrics at Chris Hani Bargawanath Hospital, Soweto.	Impact of HIV on in-hospital mortality	Absolute numbers and proportions Chi-square tests, ANOVA and chi-square test for trend where appropriate	Increase in proportion of HIV-associated deaths from 6.7% to 46.1%. Common causes of death were pneumonia, gastroenteritis, sepsis and meningitis. Case fatality rates >6 times higher in HIV-infected with pneumonia and gastroenteritis.
Shin JJ & Lee NJ, et al. (2015)	United States 2000-2012	Kids' Inpatient Database (KID)	Descriptive analysis of paediatric cervical spine injury	Admission trends Cause of injury Mortality rates LOS Cost	Prevalence 2%, Mortality 5% Almost 60% transport-related. Commoner in older children but mortality higher in younger children.
Christian EA & Jin DL, et al. (2015)	United States 2000-2010	KID and NIS	Describe trends in hospitalisation of pre-term infants with intraventricular haemorrhage (IVH) and hydrocephalus	Absolute numbers Proportion with complications Mortality rates LOS Hospital cost	IVH rate increasing despite decrease in preterm births Hydrocephalus rates in IVH stable. Trend of increase in hospital stay and cost

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Woods CR & Cash ED, et al. (2015)	United States 2003-2012	KID	To describe the epidemiology and outcomes of retropharyngeal and parapharyngeal abscesses	Incidence proportion Seasonality LOS Outcomes	Incidence of these abscesses increased over the study period, more common in males, LOS longer and more expensive with surgical versus medical management.
Maxwell BG & Nies MK, et al. (2015)	United States 1997-2012	KID	Descriptive analysis of hospital admissions for paediatric pulmonary hypertension	Proportions Chi-square test for trend Costs	Results have implications for future resource management and skills development in the healthcare service.
Hasegawa K & Tsugawa Y et al. (2013)	United States 2000-2009	KID	Trends in childhood asthma hospital admissions	Hospitalisation rates per 100 000 person-years Mortality rate Chi-square test for trend	Significant declines in asthma admissions and mortality over the period; concurrent increase in use of mechanical ventilation and increase in hospital charges.
Tran CL & Ehrmann BJ, et al. (2012)	United States 1997-2006	KID	Trends in childhood hypertension	Frequency of hospitalisations for hypertension	Increase in hospitalisations for hypertension <18 years of age over a decade.
Bowman SM & Aitken ME, et al. (2012)	United States 1993-2008	NIS	Trends in childhood drowning	Incidence per 100 000 LOS	49% decline in drowning over the study period

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Leventhal JM & Martin KD, et al. (2008)	United States 1997-2003	KID	Incidence of non-accidental fractures in young children	Proportions Age-specific incidence	There was an increase in non-accidental fractures over the time period with the highest incidence in the youngest age group.
Kourtis AP & Bansil P, et al. (2007)	United States 1994-2003	NIS	Trends in paediatric HIV-related hospitalisations	Frequency Mortality proportion	71% decrease in admissions in HIV-infected children overall; 64% decrease in associated mortality. Increase in admissions for HIV-infected adolescent girls only by 23%.
Fischer TK & Viboud C, et al. (2007)	United States 1993-2003	KID	Morbidity and mortality trends for early childhood diarrhoea and rotavirus infection	Risk ratios	Black infants more likely to be hospitalised and to die from rotavirus-associated diarrhoea than white infants.
Haslam N & Hoang U, et al. (2014)	England 1960s-2011	HES Oxford record linkage database	Trends in pertussis admissions across five decades.	Admission rates Age- and sex-standardised rates	Peaks in admission rates in 1973 and 1982 followed by consistent decline and low levels until end of study period.

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Kypri K & Chalmers DJ, et al. (2001)	New Zealand 1987- 1996	National hospital discharge database	Epidemiology of child injury	Admission rate Proportions	Injury second commonest cause of hospital admission, male predominance, leading cause due to falls with commonest injury an upper limb fracture.
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5. Identification of gaps or need for further research

Large national databases that contain routine hospital discharge data can provide useful insights into the health and healthcare access of populations, prevailing healthcare practices and trends in specific conditions over time. South Africa does not possess such a national database, but there are individual healthcare institutions in the country that collect administrative data obtained from discharge forms in computerised databases. Database research in healthcare is rare in South Africa, yet these databases provide readily accessible sources of health information.

There is a clear need for continued research around child health indicators in South Africa. Population-level data is improving but incomplete and costly to obtain. Computerised hospital databases routinely store data on patients discharged from hospital that includes useful clinical information such as diagnostic codes and outcomes at discharge. As the backbone of healthcare in South Africa, the DHS would function best if it were more locally responsive. Facility-level research would enable this kind of responsiveness, strengthening the health system while contributing to improved health outcomes for catchment populations.

References

1. United Nations General Assembly. United Nations Millennium Declaration. 2000. Available at: <http://www.un.org/millennium/declaration/ares552e.pdf> (accessed 04 February 2015).
2. Sanders D, Bradshaw D, Ngongo N. The status of child health in South Africa. In: Kibel M, Lake L, Pendlebury S, Smith C, editors. South African Child Guage 2009/2010 Cape Town: Children's Institute, University of Cape Town; 2010. p. 29-40.
3. Bryce J, Daelmans B, Dwivedi A, Fauveau V, Lawn JE, Mason E, et al. Countdown to 2015 for maternal, newborn, and child survival: the 2008 report on tracking coverage of interventions. *Lancet* 2008; 371:1247-1258.
4. Bhutta ZA, Chopra M, Axelson H, Berman P, Boerma T, Bryce J, et al. Countdown to 2015 decade report (2000-10): taking stock of maternal, newborn, and child survival. *Lancet* 2010; 375: 2032-2044.
5. McKerrow N, Mulaudzi M. Child mortality in South Africa: using existing data. In: Fonn S, Padarath A, editors. South African Health Review 2010. Durban: Health Systems Trust; 2010. p. 59-71. Available at <http://www.hst.org.za/publications/876>.
6. Statistics South Africa. Millennium Development Goals, Country Report 2013. Pretoria: Statistics South Africa; 2013. p. 62-69. Available at http://www.statssa.gov.za/wp-content/uploads/2013/10/MDG_October-2013.pdf.
7. Bamford L. Maternal, newborn and child health. In: Padarath A, English R, editors. South African health review 2012/13. Durban: Health Systems Trust; 2013. p. 49-66. Available at <http://www.hst.org.za/publications/south-african-health-review-2012/3>.
8. Nicol E, Bradshaw D. Maternal, newborn and child survival: data challenges. In: Fonn S, Padarath A, editors. South African Health Review 2010. Durban:

- Health Systems Trust; 2010. p. 73-78. Available at <http://www.hst.org.za/publications/876>.
9. Statistics South Africa. Millennium Development Goals, Country Report 2013. Pretoria: Statistics South Africa; 2013. p. 70-77. Available at: http://www.statssa.gov.za/wp-content/uploads/2013/10/MDG_October-2013.pdf.
 10. Chopra M, Daviaud E, Pattinson R, Fonn S, Lawn JE. Saving the lives of South Africa's mothers, babies, and children: can the health system deliver? *Lancet* 2009; 374: 835-846.
 11. Countdown to 2015, Health Metrics Network. Monitoring maternal, newborn and child health: understanding key progress indicators. UNICEF, WHO 2011. Available at: http://www.who.int/healthmetrics/news/monitoring_maternal_newborn_child_health.pdf.
 12. Barron P, Pillay Y, Doherty T, Sherman S, Jackson D, Bhardwaj S, et al. Eliminating mother-to-child HIV transmission in South Africa. *Bull World Health Organ* 2013; 91: 70-74.
 13. Schoub BD, Ngcobo NJ, Madhi S. The National Advisory Group on Immunization (NAGI) of the Republic of South Africa. *Vaccine* 2010; 28 (Suppl 1): A31-34.
 14. Msimang VMY, Page N, Groome MJ, Moyes J, Cortese MM, Seheri M, et al. Impact of rotavirus vaccine on childhood diarrheal hospitalization after introduction into the South African public immunization program. *Pediatr Infect Dis J* 2013; 32: 1359-1364.
 15. Madhi SA, Bamford L, Ngcobo N. Effectiveness of pneumococcal conjugate vaccine and rotavirus vaccine introduction into the South African public immunization programme. *S Afr Med J* 2014; 104 (3 Suppl 1): 228-234.

16. Madhi SA, Groome MJ, Zar HJ, Kapongo CN, Mulligan C, Nzenze S, et al. Effectiveness of pneumococcal conjugate vaccine against presumed bacterial pneumonia hospitalisation in HIV-uninfected South African children: a case-control study. *Thorax* 2015; 0: 1-7.
17. Coovadia H, Jewkes R, Barron P, Sanders D, McIntyre D. The health and health system of South Africa: historical roots of current public health challenges. *Lancet* 2009; 374:817-834.
18. Kautzky K, Tollman SM. A perspective on primary health care in South Africa. In: Baron P, Roma-Rearden J, editors. *South African Health Review 2008*. Durban: Health Systems Trust; 2008. p. 17-30. Available at <http://www.hst.org.za/publications/841>.
19. Tollman SM. The Pholela Health Centre - the origins of community-oriented primary health care. *S Afr Med J* 1994; 84(10): 653-658.
20. International Conference on Primary Health Care. Declaration of Alma Ata. 1978. Available at: http://www.who.int/publications/almaata_declaration_en.pdf
21. Benatar SR. Medicine and health care in South Africa - five years later. *N Engl J Med* 1991; 325(1): 30-36.
22. Benatar S. Editorial. The challenges of health disparities in South Africa. *S Afr Med J* 2013; 103(3): 154-155.
23. Benatar SR. Health care reform in the new South Africa. *N Engl J Med* 1997; 336(12): 891-895.
24. Benatar SR. Health care reform and the crisis of HIV and AIDS in South Africa. *N Engl J Med* 2004; 351(1): 81-92.
25. Harris B, Goudge J, Ataguba JE, McIntyre D, Nxumalo N, Jikwana S, et al. Inequities in access to health care in South Africa. *J Pub Health Pol* 2011; 32 (S1): S102-S123.

26. Harrison D. An overview of health and health care in South Africa 1994 - 2010: Priorities, Progress and Prospects for New Gains. A discussion document commissioned by the Henry J. Kaiser family foundation to help inform the National Health Leaders' Retreat Muldersdrift, 2010:1-40.
27. Abdool Karim SS, Churchyard GJ, Abdool Karim Q, Lawn SD. HIV infection and tuberculosis in South Africa: an urgent need to escalate the public health response. *Lancet* 2009; 374: 921-933.
28. Department of Health. National Strategic Plan on HIV, STIs & TB, 2012 – 2016. Available at:
<http://www.thepresidency.gov.za/MediaLib/Downloads/Home/Publications/SANACCcallforNominations/A5summary12-12.pdf>
29. Statistics South Africa. Millennium Development Goals, Country Report 2013. Pretoria: Statistics South Africa; 2013. p. 79-90. Available at:
http://www.statssa.gov.za/wp-content/uploads/2013/10/MDG_October-2013.pdf
30. Mayosi BM, Flisher AJ, Lalloo UG, Sitas F, Tollman SM, Bradshaw D. The burden of non-communicable diseases in South Africa. *Lancet* 2009; 374:934-947.
31. Seedat M, Van Niekerk A, Jewkes R, Suffla S, Ratele. Violence and injuries in South Africa: prioritising an agenda for prevention. *Lancet* 2009; 374:1011-1022.
32. Chopra M, Lawn JE, Sanders D, Barron P, Abdool Karim SS, Bradshaw D, et al. Achieving the health Millennium Development Goals for South Africa: challenges and priorities. *Lancet* 2009; 374: 1023 – 1031.
33. Mayosi BM, Lawn JE, van Niekerk A, Bradshaw D, Abdool Karim SS, Coovadia HM, et al. Health in South Africa: changes and challenges since 2009. *Lancet* 2012; 380(9858): 2029-2043.

34. Matsoso MP, Fryatt R. National Health Insurance: the first 18 months. In: Padarath A, English R, editors. South African Health Review 2012/13. Durban: Health Systems Trust; 2013. p. 21-36. Available at <http://www.hst.org.za/publications/south-african-health-review-2012/2013>.
35. Oboirien KO, Eyles J, McIntyre D, Chimbindi, Harris B, Orgill M, et al. Understanding roles, enablers and challenges of District Clinical Specialist Teams in strengthening primary health care in South Africa. In: Padarath A, King J, English R, editors. South African Health Review 2014/2015. Durban: Health Systems Trust; 2015. p. 45-56. Available at <http://www.hst.org.za/publications/south-african-health-review-2014/15>.
36. Chitiga-Mabugu M, Tsoanamatsie N. The relevance and possibility of attaining the Millennium Development Goals by 2015 in South Africa. HSRC Policy Brief 2013.
37. Safran C, Chute CG. Exploration and exploitation of clinical databases. *Int J Bio-med Comp* 1995; 39:151 -156.
38. O'Malley KJ, Cook KF, Price MD, Wildes KR, Hurdle JF, Ashton CM. Measuring diagnoses: ICD code accuracy. *Health Services Research* 2005; 40(5): 1620-1639.
39. Green J, Wintfield N. How accurate are hospital discharge data for evaluating effectiveness of care? *Med Care* 1993; 31(8):719-731.
40. Hill AM. Trends in paediatric medical admissions. *Br Med J* 1989; 298:1479-1483.
41. Saxena S, Bottle A, Gilbert R, Sharland M. Increasing short-stay unplanned hospital admissions among children in England; time trends analysis '97-'06. *PloS ONE* 2009; 4(10): 1 – 6.
42. Connors C, Millar WJ. Changes in children's hospital use. Statistics Canada, Health Reports 1999; 11(2): 9-20.

43. Macy ML, Stanley RM, Lozon MM, Sasson C, Gebremariam A, Davis MM. Trends in high-turnover stays among children hospitalized in the United States, 1993-2003. *Pediatrics* 2009; 123(3): 996-1002.
44. Chavez GF, Ellis AA. Pediatric hospital admissions for measles. Lessons from the 1990 epidemic. *West J Med* 1996; 165(1-2): 20-25.
45. Zwi KJ, Pettifor JM, Soderlund N. Paediatric hospital admissions at a South African urban regional hospital: the impact of HIV, 1992-1997. *Ann Trop Paed* 1999; 19:135-142.
46. Zwi K, Pettifor J, Soderlund N, Meyers T. HIV infection and in-hospital mortality at an academic hospital in South Africa. *Arch Dis Child* 2000; 83:227-230.
47. Meyers T, Dramowski A, Schneider H, Gardiner N, Kuhn L, Moore D. Changes in paediatric HIV-related hospital admissions and mortality in Soweto, South Africa 1996-2011: light at the end of the tunnel? *J Acquir Immune Defic Syndr* 2012; 60(5): 503-510.
48. Patrick ME, Stephen CR. Child PIP: Making mortality meaningful by using a structured mortality review process to improve the quality of care that children receive in the South African health system. *S Afr J Child Health* 2008; 2(2): 38-42.
49. Harper K. An overview of Child PIP national data 2012-2013. In: Stephen CR, editor. *Saving Children 2012-2013 An eighth survey of child healthcare in South Africa*. Pretoria: Tshepesa Press; 2016. p 1-13. Available at <http://www.childpip.org.za>
50. Steinberg H. An overview of Child PIP national data 2011. In: Stephen CR, Bamford LJ, editors. *Saving Children 2010-2011 A seventh survey of child health care in South Africa*. Pretoria: Tshepesa Press, MRC, CDC; 2013. p 1-13. Available at <http://www.childpip.org.za>

51. Shin JI, Lee NJ, Cho SK. Pediatric cervical spine and spinal cord injury: a national database study. *Spine* (2016).
52. Christian EA, Jin DL, Attenello F, Wen T, Cen S, Mack WK, et al. Trends in hospitalization of preterm infants with intraventricular haemorrhage and hydrocephalus in the United States, 2000-2010. *J Neurosurg Pediatr* 2015: 1-10.
53. Woods CR, Cash ED, Smith AM, Smith MJ, Myers JA, Espinosa CM, et al. Retropharyngeal and parapharyngeal abscesses among children and adolescents in the United States: epidemiology and management trends, 2003-2012. *J Pediatr Infect Dis Soc* 2015: 1-10.
54. Maxwell BG, Nies MK, Ajuba-Iwuji CC, Coulson JD, Romer LH. Trends in hospitalization for pediatric pulmonary hypertension. *Pediatrics* 2015; 136(2): 241-250.
55. Hasegawa K, Tsugawa Y, Brown DF, Camargo CA Jr. Childhood asthma hospitalizations in the United States, 2000-2009. *J Pediatr* 2013; 163(4): 1127-1133.
56. Tran CL, Ehrmann BJ, Messer KL, Herreshoff E, Kroeker A, Wickman L, et al. Recent trends in healthcare utilization among children and adolescents with hypertension in the United States. *Hypertension* 2012; 60(2): 296-302.
57. Bowman SM, Aitken ME, Robbins JM, Baker SP. Trends in US pediatric drowning hospitalizations, 1993-2008. *Pediatrics* 2012; 129(2): 275-281.
58. Leventhal JM, Martin KD, Asnes AG. Incidence of fractures attributable to abuse in young hospitalized children: results from analysis of a United States database. *Pediatrics* 2008; 122(3): 599-604.
59. Kourtis AP, Bansil P, Posner SF, Johnson C, Jamieson DJ. Trends in hospitalizations of HIV-infected children and adolescents in the United States: analysis of data from the 1994-2003 Nationwide Inpatient Sample. *Pediatrics* 2007; 120(2): 236-243.

60. Hospitalizations and deaths from diarrhea and rotavirus among children <5 years of age in the United States, 1993-2003. *J Infect Dis* 2007; 195(8): 1117-1125.
61. Haslam N, Hoang U, Goldacre MJ. Trends in hospital admission rates for whooping cough in England across five decades: database studies. *J Royal Soc Med* 2014; 107(4): 157-162.
62. Kypri K, Chalmers DJ, Langley JD, Wright CS. Child injury morbidity in New Zealand, 1987-1996. *J Paediatr Child Health* 2001; 37(3): 227-234.

Part III

JOURNAL MANUSCRIPT

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Admission trends at Red Cross War Memorial Children's Hospital, Cape Town: 2004 to 2013

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ABSTRACT

Background. Routinely collected patient information has the potential to yield valuable information about health systems functioning and population health, but there have been few comprehensive analyses of paediatric admissions at South African hospitals.

Objectives. The aim of this study was to investigate trends in hospitalisation and outcomes at Red Cross War Memorial Children's Hospital (RCCH), a major referral hospital for children in the Western Cape and South Africa.

Methods. Using routinely collected observational health data from the hospital informatics system, we investigated admissions between 2004 and 2013. Clinical classification software was used to group ICD-10 codes to rank causes for the period 2008 to 2013 when ICD-10 codes were widely available. Analyses examined trends in medical and surgical admissions over time.

Results. There were 215 536 admissions over 10 years in 129 733 patients. Admissions increased by 9.3% (95% CI 8.9-9.7) with increases in the general medical wards (5%) medical specialty wards (74%), Burns Unit (73%), and ICU (16%) over a decade. In contrast, admissions decreased to the Trauma Unit (21%) and short-stay medical wards (1%). In-hospital mortality decreased by 54% (ptrend <0.001) over 10 years. Diarrhoea or lower respiratory tract illness were the commonest cause for medical admission although both admissions and deaths due to these conditions decreased between 2008 and 2013, which coincided with the national introduction of related vaccines. Similarly, tuberculosis admissions and deaths decreased over this period. These trends could be due to a concurrent decrease in HIV co-morbidity (ptrend<0.001). Trauma was the commonest reason for surgical admission.

Conclusion. Paediatric in-hospital mortality decreased consistently over a decade despite an overall increase in admissions. Pneumonia and diarrhoea admissions have decreased markedly over a 6-year period but remain the most important causes of hospitalisation.

³ The student is noted as single author in this manuscript as this is the student's own work. For the actual journal submission the student's supervisors, Landon Myer and Heather Zar, will be added as co-authors.

1. INTRODUCTION

Child health in South Africa has faced significant challenges in the recent past largely as a result of poverty, over-burdened healthcare services, HIV and other infectious diseases. ^[1-3] This dire situation recently saw an about turn which was captured by an improving under-5 mortality rate (U5MR) ^[4] – a sensitive indicator of child health – in response to health interventions targeting HIV, new vaccines, Integrated Management of Childhood Illness (IMCI), and other health policies aimed at promoting child health. ^[4,5] However, latest estimates of the U5MR indicate that progress has stalled with the U5MR hovering at 40 deaths per 1000 livebirths ^[6] – 20 deaths more than the Millennium Development Goal (MDG) target for 2015. ^[7,8] Furthermore, as a national estimate, the U5MR cannot be disaggregated to inform locally at the District Health Service (DHS)-level; for it is precisely at this level that indicators of child health have to be appraised and addressed if further progress in child health is to be made. ^[5]

Hospital administrative databases are valuable repositories of clinical information that can provide important insights into the health needs of populations ^[9] and can be used to develop locally relevant indicators of child health and well-being. ^[10] Several international paediatric hospital database studies have highlighted various issues pertinent to child health. ^[11-15] In South Africa, a recent analysis of a hospital database documented the burden on adult tertiary medical services in the Western Cape. ^[16] At Baragwanath hospital in Soweto, a series of studies used discharge data to detail HIV-related disease burdens in that hospital's paediatric medical wards. ^[17-19] However, analyses of high-quality paediatric hospital data remain scarce in SA, and few local studies document paediatric morbidity across medical and surgical causes.

Red Cross War Memorial Children's Hospital (RCCH) is a major referral hospital for children of the Western Cape and South Africa, which collects routine in-hospital information in a computerised database. The aim of this study was to examine mortality and morbidity trends and outcomes at RCCH as indicators of child health of the local population. In addition, the impact of recent changes in healthcare practices and newly opened healthcare facilities on the utilisation of this hospital was also assessed.

2. METHODS

2.1 Background

RCCH is a 283-bed paediatric referral hospital that provides tertiary and quaternary services for children up to the age of 13 years. The source population consists largely of children from the surrounding Western Cape health districts; however, more specialised services are available to children from the rest of the country. There is no dedicated neonatal unit and the hospital does not provide any obstetric services. Children with medical conditions are admitted to the short stay ward overnight; thereafter they are either discharged or transferred to the general medical wards, sub-specialty wards or to paediatric units at other hospitals in the teaching complex. Critically ill children may be admitted directly to the Intensive Care Unit (ICU). During the study period only the ICU saw an increase in bed capacity to 22 beds. Renovations during this period have upgraded the medical wards improving high care capability.

2.2 Data source

RCCH uses the Clinicom information system to store data on all hospital admissions and discharges in two separate databases. This study is a descriptive analysis of observational routinely collected health data available in the Clinicom database on all patients admitted to RCCH. Admissions data is abstracted from ward admission and internal transfer forms that are completed by ward clerks. Discharge data is abstracted from discharge forms completed by junior doctors upon patient discharge from the hospital. We were unable to link these two datasets, as there were no unique identifiers common to both. Therefore, the admissions dataset was used for all analyses except 'length of hospital stay', for which we used the discharge dataset.

The primary objectives of this study are i) to provide a description of overall admission trends across a decade with sub-analyses describing specific ward, sex and age distributions of admissions and length of hospital stay ii) to describe mortality trends across a decade - in-hospital mortality was calculated as the proportion of admissions with death as the outcome for each year, and iii) to rank, compare and describe trends in common admission diagnoses and cause-specific mortality. The

secondary objective of this study is to investigate the impact of HIV as a co-morbid condition on the findings from our primary analysis.

The University of Cape Town's Faculty of Health Sciences' Human Research Ethics Committee approved this project, HREC REF: 764/2014; permission was also obtained from the Hospital Research Review Committee of RCCH.

2.3 Data Elements

Stored information includes demographic data (age in days, age in weeks, age in months, age in years, and sex), billing information, a variable indicating admission or internal transfer, activity dates, ward name (16 different wards), length of hospital stay in days (from the discharge database), ICD-10 diagnostic codes (one primary, one subsidiary and 10 secondary diagnosis codes) and method of discharge (with a description such as discharged, died or undefined). The quality and reliability of data from this database is yet to be established

2.4 Statistical analyses

Selected variables from the Clinicom database, with entries starting in 2001 up to 2014, were transferred in spreadsheet format for analysis in Stata version 12 (StataCorp. 2011, College Station, Texas, USA). However, only data from 2004 to end 2013 were used in these analyses, as the database became an integral part of the hospital administrative system from 2004 onward.

Missing data is a well-documented feature of hospital administrative databases that could result in bias. All variables were therefore explored for missing data. Large chunks of data were missing from the primary diagnosis variable before 2008. Missing ICD-10 codes were explored by cross-tabulation and chi-square tests for associations with admission ward, mortality, sex and age.

For the analysis of admissions to the hospital, the admissions database was used for total and ward admissions, demographic data and the exploration of mortality. The discharge database was used only for analysis of length of hospital stay. We studied all admissions between 2004 and 2013 for the first two objectives. Changes in admissions were calculated as the percentage difference between 2013 and 2004.

For the ranking of common diagnoses only first admissions to specific medical (general medical and short stay wards) and surgical wards (general surgical, day

surgery unit and Trauma Unit) were explored to exclude readmissions for chronic conditions. There were no age exclusions. Primary ICD-10 diagnostic codes were grouped into 259 distinct clinical categories according to clinical classification software (CCS) developed by the Healthcare Cost and Utilization Project of the United States (HCUP-US).^[20] This classification is widely used in database studies that analyse diagnostic trends. All original CCS codes were used in the rankings except for the clinical entity ‘lower respiratory tract illness’, which was created by combining the codes for pneumonia, acute bronchitis, bronchiolitis, influenza and unspecified acute lower respiratory infection. Rankings were compared between 2008 and 2013 when ICD-10 codes were more complete. A sub-analysis by age category was performed for this evaluation. These codes were also used to rank causes of mortality.

For the analysis of disease patterns, all admissions under the age of five years between 2008 and 2013 were included. The CCS category of pneumonia was maintained and the CCS category of intestinal infection - which includes all infectious causes of diarrhoea - was reported as ‘diarrhoea’. The CCS category for ‘HIV infection’ was searched for in the subsidiary diagnosis and all secondary diagnosis variables. All first admissions with a secondary diagnosis of HIV were included in this analysis.

Results were reported as frequencies, percentages or proportions; medians and interquartile ranges describe continuous variables. Precision of point estimates was determined by means of 95% confidence intervals. We computed the chi-square test for trend to assess significant changes in categorical variables over time. Wilcoxon tests or t-tests were computed to test for significant changes within continuous variables at the start and end of examined periods.

3. RESULTS

3.1 Admission and mortality trends

From 2004 to 2013, there was a total of 215 536 admissions to RCCH accounted for by 129 733 patients with a median of 1 admission (IQR 1 to 224) per patient during this period. Overall admissions increased by 9.3% (95% CI 8.9-9.7%) and mean monthly admissions increased by 9.3% (95% CI 8.0-10.9%; $p=0.019$) over a decade,

while the number of new patients dropped by 8.6% (95% CI 8.1-9.0%) during this period. Table 3.1 provides a general description of annual hospital admissions across the decade. Admissions to the general medical wards and surgical wards increased by 5% (95% CI 3-6%) and 9% (95% CI 8-10%) between 2004 and 2013 respectively, but their contributions to total admissions remained proportionately the same. Admissions to the medical subspecialty wards increased by 74% (95% CI 72-76%), admissions to the Burns Unit increased by 73% (95% CI 70-76%), and admissions to the Intensive Care Unit (ICU) increased by 16% (95% CI 13-19%) over the decade. Trauma Unit admissions decreased by 21% (95% CI 20-23%) and admissions to the short-stay medical wards decreased by 1% (95% CI 0.8-1.2%) across the decade.

The median age of admissions increased by 6 months over the 10-year period ($z = -9.481$; $p < 0.001$). The general medical wards and ICU admitted younger patients with a median age less than 1 year. Burns unit admissions had a median age of around 2 years while the Trauma Unit and medical specialty wards admitted older children with an average age of 5-6 years (Appendix B – Table 4.5). The sex distribution remained largely unchanged over the decade but with a consistent preponderance of male admissions (58%). However, this percentage differed between specialties with surgical wards and the Trauma Unit admitting proportionately more male patients than any of the other wards (Appendix B – Table 4.5).

The length of stay of medical admissions decreased from a median of 9 days in 2004 to a median of 7 days in 2013 ($z = 9.13$; $p < 0.001$). The length of stay for surgical admissions remained constant across the decade at a median of 2 days.

Sixty-six percent of primary ICD-10 codes were missing from the dataset in 2004 compared to only 1.5% in 2013. Acute care wards had a higher percentage of missing data over the 10-year period compared to other wards. Missing data were also associated with death as patients that died were more likely to have missing ICD-10 codes than those that survived ($\chi^2 = 156.289$; $p < 0.001$) (Appendix B – Tables 4.1 – 4.4).

Overall mortality decreased steadily across the decade by 54% ($\chi^2 = 179.42$; $p_{trend} < 0.001$) while the median age at death increased by 7 months over this period ($z = -2.578$; $p = 0.01$) The in-hospital mortality proportion in children under five years decreased by 58% across the decade from 32.4 deaths per 1000 children under-5 in 2004 to 13.7 deaths per 1000 children under-5 in 2013. Admissions to the ICU had

the highest likelihood of death whereas admissions to surgical wards (including Trauma and Burns Units) had the lowest mortality (Appendix B – Table 4.6).

Table 3.1: Description of admissions to RCCH January 2004 – December 2013

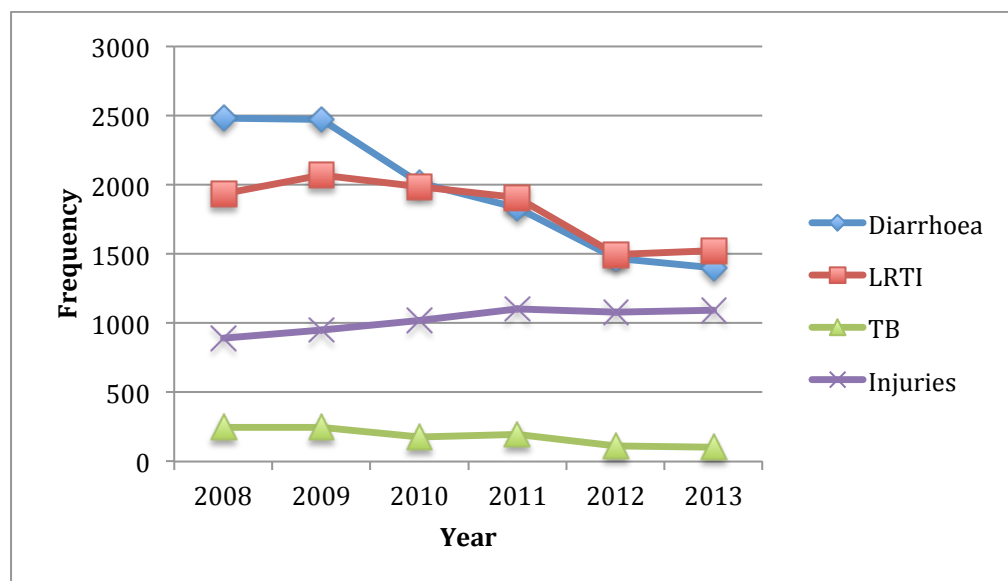
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	p-values
Total Admissions, N	19 898	20 238	21 552	21 432	21 536	22 880	22 670	22 645	20 934	21 751	
New patients, N	12 980	12 875	13 680	13 329	13 129	13 874	13 703	12 728	11 565	11 870	
Mean admission/month, n	1 658	1 687	1 796	1 786	1 795	1 907	1 889	1 887	1 745	1 813	
Age in years, median (IQR)*	2.3 (0.7-6.2)	2.4 (0.8-6.3)	2.2 (0.7-5.9)	2.0 (0.7-6.1)	2.0 (0.7-5.6)	2.1 (0.7-5.7)	2.1 (0.7-5.7)	2.6 (0.9-6.1)	2.8 (1.0-6.4)	2.8 (1.0-6.4)	z=-9.481/ p<0.001
Female, n (%)	8 313 (42)	8 599 (43)	9 245 (43)	9 189 (43)	9 017 (42)	9 828 (43)	9 559 (42)	9 574 (42)	8 865 (42)	9 105 (42)	
ICD-10 missing, n (%)	13 078 (66)	6 470 (32)	7 659 (36)	3 811 (18)	772 (4)	640 (3)	755 (3)	629 (3)	437 (2)	328 (1.5)	
Ward admissions, n (%)											X ² /ptrend
General Medical	745 (4)	701 (3)	636 (3)	702 (3)	663 (3)	744 (3)	703 (3)	594 (3)	658 (3)	779 (4)	6.06/0.014
Short-stay medical	7 667 (39)	7 677 (38)	8 688 (40)	9 239 (43)	9 527 (44)	10 258 (45)	9 982 (44)	9 112 (40)	7 499 (36)	7 591 (35)	56.60/<0.001
Medical subspecialty	2 117 (11)	2 214 (11)	2 405 (11)	2 530 (12)	2 689 (12)	2 930 (13)	2 866 (13)	3 472 (15)	3 387 (16)	3 690 (17)	776.1/<0.001
Surgical wards	3 359 (17)	3 482 (17)	3 564 (17)	3 458 (16)	3 230 (15)	3 299 (14)	3 202 (14)	3 677 (16)	3 488 (17)	3 658 (17)	6.62/0.01
Trauma Unit	2 119 (11)	2 094 (10)	1 985 (9)	1 635 (8)	1 576 (7)	1 614 (7)	1 819 (8)	1 774 (8)	1 742 (8)	1 667 (8)	175.6/<0.001
ICU	487 (2)	404 (2)	390 (2)	389 (2)	494 (2)	482 (2)	523 (2)	455 (2)	512 (2)	564 (3)	14.62/<0.001
Burns Unit	693 (3)	786 (4)	899 (4)	906 (4)	891 (4)	940 (4)	1 138 (5)	926 (4)	1 026 (5)	1 200 (6)	113.7/<0.001
Day Surgical	2 711 (14)	2 880 (14)	2 985 (14)	2 573 (12)	2 466 (11)	2 613 (11)	2 437 (11)	2 635 (12)	2 622 (13)	2 602 (12)	101.5/<0.001
Length of stay in days, median (IQR)											
General medical	9 (5-16)	8(5-14)	8(5-14)	8(5-15)	8(5-15)	8(5-15)	8(5-15)	8(5-15)	8(5-13)	7(4-12)	z/p-value
Surgical wards	2(1-5)	2(1-4)	2(1-4)	2(1-4)	2(1-5)	2(1-5)	2(1-5)	2(1-4)	2(1-4)	2(1-4)	9.13/p<0.001
Deaths											3.14/p=0.002
Total deaths, n (% admissions)	342 (1.7)	346 (1.7)	334 (1.5)	316 (1.5)	289 (1.3)	286 (1.3)	264 (1.2)	211 (0.9)	190 (0.9)	156 (0.7)	X ² =179.42
Age in years, median (IQR)	0.6 (0.2-2.2)	0.5(0.2-2.5)	0.5 (0.2-1.9)	0.7(0.2-2.6)	0.7(0.2-3.5)	0.8(0.2-2.2)	0.9(0.3-4.2)	1 (0.2-4.6)	1.1(0.2-5.3)	1.2 (0.3-3.9)	ptrend<0.001
Female, n (%)	161 (47)	169 (49)	164 (49)	171 (54)	133 (46)	140 (49)	125 (47)	101 (48)	77 (41)	69 (44)	z=-2.578
Deaths in under-5's, n/N	293/13 700 (2.1)	290/13 725 (2.1)	284/14 911 (1.9)	256/15 201 (1.7)	228/15 457 (1.5)	241/16 374 (1.5)	205/16 159 (1.3)	164/15 607 (1.1)	140/13 948 (1.0)	122/14 460 (0.8)	p=0.01
(%<5 admissions)											
Under-5 deaths/1000patients <5	32.4	32.5	28.8	25.5	22.5	22.5	19.4	16.9	16.1	13.7	
(No. of patients <5)	9 049	8 935	9 853	10 033	10 124	10 712	10 586	9 732	8719	8898	

*IQR = Interquartile range

3.2 Common causes of morbidity and mortality

There was a total of 11 594 first medical and surgical admissions to RCCH in 2008 of which 478 (4%) had missing ICD-10 codes. In 2013, of the 9 978 first medical and surgical admissions, only 144 (1%) had missing ICD-10 codes. Common diagnoses were therefore compared across this 6-year period when missing ICD-10 data were minimal (Table 3.3). For medical admissions, diarrhoea or lower respiratory tract illness (LRTI) remained the top two reasons for hospitalisation but appear to be declining (Fig 3.2). Convulsions, which include epilepsy and febrile seizures, remained the third commonest presentation. Tuberculosis (TB) was the fourth commonest cause of medical admission in 2008, occurring more commonly in older age groups (Appendix B – Table 4.7), but did not feature in 2013. Poisoning by medicines or drugs – prominent in the 1 – 5 year age group – decreased over this period as well. Asthma admissions had increased due to a marked rise in these admissions in older children (Appendix B – Table 4.7). For surgical conditions, the commonest presentations were for injuries (including fractures) followed by skin and subcutaneous tissue infections and tonsil disorders. There were no striking changes in the rankings for surgical conditions over the 6 years; however, injuries⁴ appear to be increasing (Fig 3.2). Congenital anomalies were commonest in the youngest age category, while injuries and tonsil infections were commoner in older age categories. (Appendix B – Table 4.8).

Figure 3.2 Line graph depicting trends of common admission disorders at RCCH, 2008-2013



⁴ Injuries were calculated as the sum of injury diagnostic groups appearing in the top 10 ranking i.e. ‘other injuries and conditions due to external causes’, upper limb fractures and lower limb fractures.

Table 3.3: Top 10 ranking of medical and surgical admissions at RCCH for 2008 and 2013.

2008				2013			
Medical (General medical and short stay wards)							
Rank	Disorder	<i>f</i>	Proportion of hospitalisation % (95% CI)	Rank	Disorder	<i>f</i>	Proportion of hospitalisation % (95% CI)
1	Diarrhoea	2 482	36 (35-37)	1	LRTI	1 523	28 (27-30)
2	LRTI*	1 936	28 (27-29)	2	Diarrhoea	1 400	26 (25-27)
3	Convulsions	488	7 (6-8)	3	Convulsions	371	7 (6-8)
4	Tuberculosis	249	4 (3-4)	4	Meningitis	221	4 (4-5)
5	Meningitis	217	3 (3-4)	5	Septicaemia	213	4 (3-5)
6	Septicaemia	214	3 (2-4)	6	COPD & Bronchiectasis	167	3 (3-4)
7	Poisoning by meds/drugs	132	2 (1.6-2.3)	7	Asthma	128	2 (2-3)
8	Asthma	121	2 (1.4-2.1)	8	Nausea & vomiting	119	2 (2-3)
9	Other URTI†	96	1 (1.1-1.7)	9	Poisoning by meds/drugs	116	2 (2-3)
10	Viral infection	69	1 (0.8-1.3)	10	Other URTI	115	2 (2-3)
Total ICD-10 codes		6 936 (missing 140)		Total ICD-10 codes		5 382 (missing 48)	
Surgical (Surgical wards, Day surgery & Trauma Unit)							
Rank	Disorder	<i>f</i>	Proportion of hospitalisation % (95% CI)	Rank	Disorder	<i>f</i>	Proportion of hospitalisation % (95% CI)
1	Skin & subcutaneous tissue infections	460	11 (10-12)	1	Other injuries & conditions due to external causes	628	14 (13-15)
2	Other injuries & conditions due to external causes#	372	9 (8-10)	2	Skin & subcutaneous tissue infections	360	8 (7-9)
3	Acute & chronic tonsillitis	325	8 (7-9)	3	Acute & chronic tonsillitis	355	8 (7-9)
4	Upper limb fracture	309	7 (7-8)	4	Upper limb fracture	262	6 (5-7)
5	Abdominal hernia	292	7 (6-8)	5	Abdominal hernia	236	5 (5-6)
6	Lower limb fracture	211	5 (4-6)	6	Lower limb fracture	205	5 (4-5)
7	Other eye disorders	197	5 (4-5)	7	Other eye disorders	193	4 (4-5)
8	Other congenital anomalies	175	4 (4-5)	8	Other congenital anomalies	175	4 (3-5)
9	Genito-urinary congenital anomalies	147	4 (3-4)	9	Genito-urinary congenital anomalies	156	4 (3-4)
10	Other male genital disorders	135	3 (3-4)	10	Medical examination or evaluation	135	3 (3-4)
Total ICD-10 codes		4 177 (missing 337)		Total ICD-10 codes		4 452 (missing 96)	

*LRTI = lower respiratory tract illness = pneumonia + bronchitis + bronchiolitis + influenza + unspecified lrti

†URTI = Upper respiratory tract illness

This diagnostic group contains all ICD-10 injury codes that are unspecified or described as “other”. It also includes codes for maltreatment syndromes, effects of foreign bodies, adverse effects, early complications of trauma, hypothermia etc. It does not include dislocations, fractures, sprains and strains, crush injuries, spinal cord injuries or open wounds. In this dataset the most frequent code in this category was for “unspecified injury of the head”.

Cause-specific mortality was explored by ranking the top five causes of death across this 6-year period (Table 3.4). Pneumonia, diarrhoea, sepsis and cardiac and circulatory congenital anomalies remained in the top five ranking for causes of death across this period. TB features among the top five causes of death for 2008 but is replaced in 2013 by the diagnostic grouping of ‘unspecified injuries and conditions due to external causes’; as a cause of death in 2013 this grouping was entirely comprised of the ICD-10 diagnosis “unspecified head injuries”. The under-1 year age category experienced the largest decrease in mortality for this period (57%), which was largely due to a decline in deaths from diarrhoea, pneumonia and cardiac and circulatory congenital anomalies (Appendix B – Table 4.9). In 2008 there were 10 deaths categorised as due to perinatal causes (Appendix B – Table 4.9).

Table 3.4: Top 5 causes of deaths at RCCH for 2008 and 2013

2008				2013		
Cause of death	<i>f</i>	Proportion of all deaths % (95%CI)	Rank	Cause of death	<i>f</i>	Proportion of all deaths % (95% CI)
Pneumonia	42	15 (11-19)	1	Sepsis	17	11 (6-17)
Diarrhoea	26	9 (6-13)	2	Pneumonia	12	8 (4-13)
Cardiac & circulatory congenital anomalies	24	8 (5-12)	3	Other injuries & conditions due to external causes	10	6 (3-11)
Sepsis	14	5 (3-8)	4	Diarrhoea	9	6 (3-11)
Tuberculosis	12	4 (2-7)	5	Cardiac & circulatory congenital anomalies	8	5 (2-10)
Total deaths	289 (17 missing codes)				156 (2 missing codes)	

3.3 Diarrhoea and pneumonia in children

Admissions to RCCH for all-cause pneumonia ($\chi^2=413.47$; $p_{trend}<0.001$) and diarrhoea ($\chi^2=478.55$; $p_{trend}<0.001$) in children under the age of 5-years between 2008 and 2013 showed a consistent downward trend, particularly from 2010 onward (Table 3.5). The proportion of diarrhoea admissions per 1000 patients under-5 decreased in 2013 by 33% (209.5/1000) compared to 2008 (313.7/1000). Deaths due to diarrhoea declined during this period as well, from a peak in 2009 (N=43) to a low in 2013 (N=9). The case fatality ratio (CFR) for diarrhoea dropped by 37.5 % between 2008 and 2013. The figures for pneumonia followed a similar trend with a 40% decline in the proportion of under-5 admissions from 2008 (185.8/1000) to 2013 (110.7/1000). Deaths due to pneumonia dropped between 2008 (N=35) and 2013 (N=12) with a reduction in the CFR of 37%. The consistent downward trend in all-cause diarrhoea and pneumonia as well as the seasonal variation of these

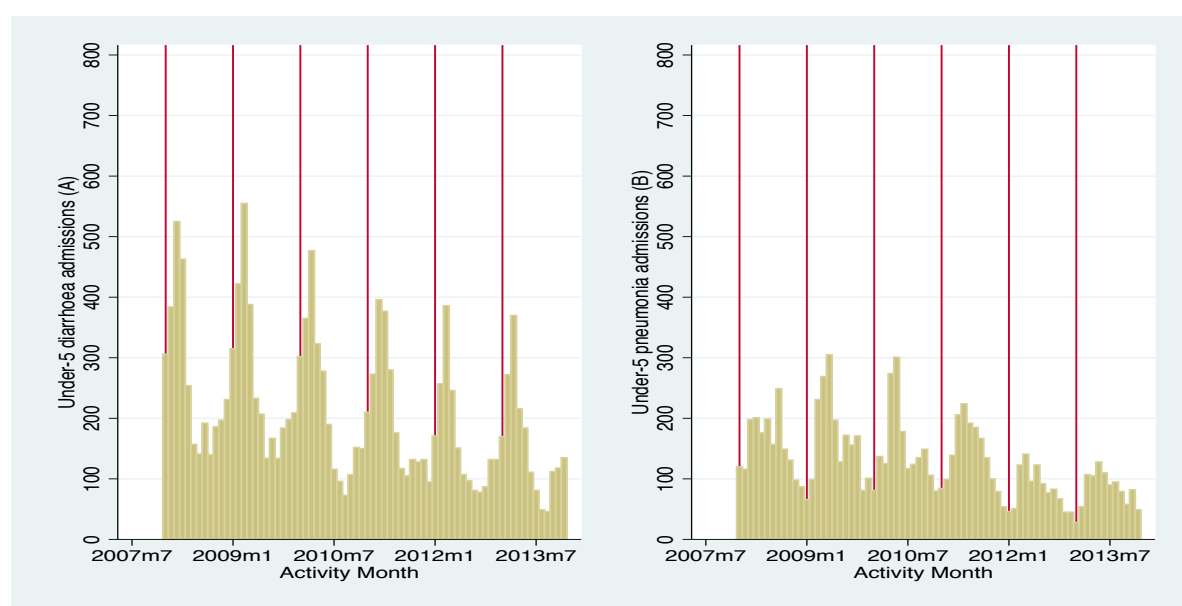
conditions is further illustrated in the histograms in Figure 3.6. Both pneumonia and diarrhoea admissions showed distinct seasonal peaks with diarrhoea admissions peaking in late summer/early autumn while pneumonia admissions peaked in early winter (fig 3.6).

Table 3.5: All-cause Diarrhoea and Pneumonia in children under 5 years at RCCH, 2008 - 2013

	2008	2009	2010	2011	2012	2013
Diarrhoea						
Cases, n	3 176	3 146	2 629	2 421	1 925	1 864
Cases /1000 patients<5y (n)	313.7	293.7	248.3	248.8	220.8	209.5
Deaths<5y, n/N (%)	25/228 (11)	43/241 (18)	32/205 (16)	24/164 (15)	8/140 (6)	9/122 (7)
Case fatality Ratio* (%)	0.8	1.4	1.2	1.0	0.4	0.5
Pneumonia						
Cases, n	1 880	1 976	1 807	1 664	989	985
Cases/1000 patients<5y (n)	185.7	184.5	170.7	171.0	113.4	110.7
Deaths<5y, n/N (%)	35/228 (15)	39/241 (16)	29/205 (14)	13/164 (8)	14/140 (10)	12/122 (10)
Case fatality ratio (%)	1.9	2.0	1.6	0.8	1.4	1.2

*Case fatality ratio = deaths/cases x 100

Figure 3.6: Monthly admissions for Diarrhoea (A) and Pneumonia (B) in children under 5 years at RCCH, 2008 – 2013.



*Red reference line at month 1 (January) of each year

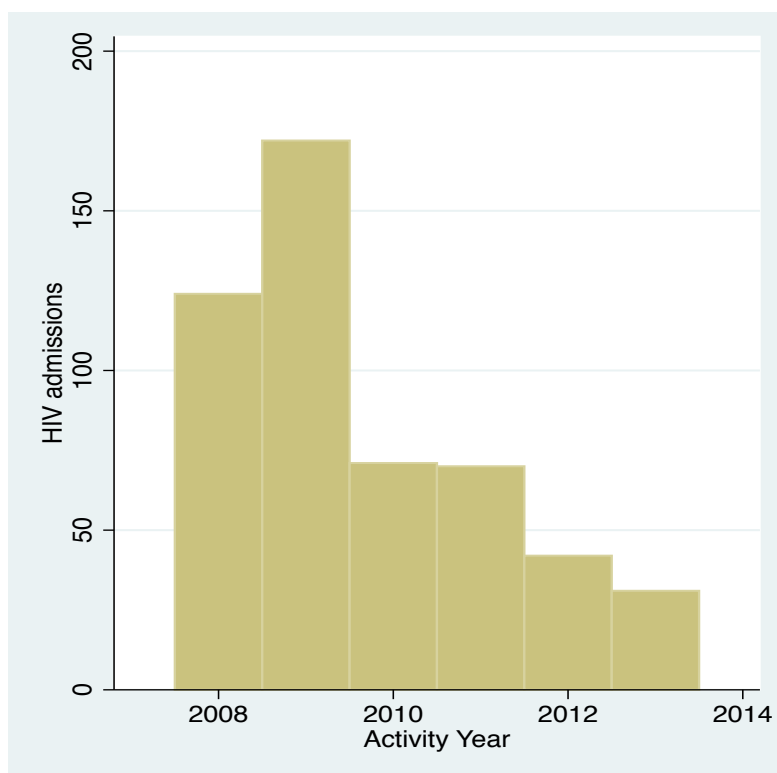
3.4 HIV Co-morbidity

The first of 10 secondary diagnosis variables was explored to gain a sense of the completeness of the record of co-morbidity. Although a similar trend of a decrease in missing data over time was observed, an average of 90% of ICD-10 codes were missing between 2008 and 2013. An exploration of all secondary diagnosis variables nevertheless showed a consistent decrease in admissions with HIV co-morbidity over a 6-year period ($\chi^2=120.10$; $p_{trend} < 0.001$).

Table 3.7: Admissions to RCCH with HIV co-morbidity during 2008 - 2013

Year	2008	2009	2010	2011	2012	2013
HIV admissions	124	172	71	70	42	31

Figure 3.8: Annual admissions to RCCH with HIV co-morbidity, 2008 – 2013



4. DISCUSSION

4.1 Discussion of Findings

Overall admissions to RCCH increased by almost 10% between 2004 and 2013 with a concomitant increase in all ward admissions except to the short-stay medical wards and Trauma Unit. This increase in admissions could be due to growth in the child population or to increased referrals from paediatric facilities at new hospitals in Mitchell's Plain and Khayelitsha ^[21] – districts that fall within the RCCH catchment area. However, there was a concurrent fall in the number of new patients, which indicates an increase in readmissions. Therefore, significant increases in admissions to medical specialty wards, ICU and to the Burns Unit suggests an increasing prevalence of chronic or complex conditions, increasing severity of disease or admission for conditions that require longer term care such as serious burns. Furthermore, the decrease in median length of stay in the general medical wards indicates a higher patient turnover, which, if due to bed pressure and early discharges, could result in more readmissions. A decrease in length of stay has been associated with a decreased threshold for admission, an increase in unplanned admissions or an increase in short stay admissions, which is often a consequence of primary healthcare inefficiencies. ^[12,13] Conversely, a decrease in length of stay could be indicative of an improvement in quality of care, earlier access to care or of less HIV, which is further supported by the consistent decline in in-hospital mortality observed across the decade.

A striking observation in the data is the preponderance of male admissions across the decade. This phenomenon was more pronounced for surgery and trauma admissions. This gender disparity in childhood morbidity is a recognised phenomenon with several studies having reported similar findings at all levels of care. A study of paediatric hospital discharge data in Hong Kong ^[22] found that 59% of general admissions were male. In addition, admissions for a range of medical conditions as well as surgical and orthopaedic admissions were dominated by male children. A Finnish study ^[23] described a preponderance of perinatal problems in boys and higher mortality in boys in the first seven years, which suggests a biological advantage for girls in the early years. Elsewhere, in a study of general practice data, ^[24] an excess of referrals and admissions for boys with the same category of illness as girls was

described, suggesting a sex-based difference in the way health issues are managed by caregivers as well as physicians.

Another striking finding is the increase in the median age of admissions and median age of deaths across the decade. The Baragwanath series of studies described a similar age effect. In the early stages of the HIV epidemic, the median age of paediatric admissions dropped due to increasing numbers of HIV-infected patients who were significantly younger than uninfected patients. ^[17,18] With the progression of the epidemic and improvements in HIV prevention and treatment, an age reversal was noted where HIV-infected patients were on average older than their counterparts. Mortality among HIV-infected children, which predominated in the younger age groups, decreased dramatically by the end of the last decade. ^[19] Hence, the success of the prevention of mother-to-child transmission (PMTCT) campaign and widespread availability of anti-retroviral therapy (ART) for paediatric HIV may explain the age effect apparent in the RCCH data. This is further supported by our finding of a decrease in HIV co-morbidity, which could also explain the marked reduction in TB cases observed within a span of six years.

Pneumonia or diarrhoea persists as the commonest reason for medical admission despite the marked reduction in cases across the studied period. In 2009, the SA government made available the pneumococcal conjugate vaccine (PCV) and rotavirus vaccine (RV) to all infants on a schedule informed by local vaccine efficacy studies. ^[25] Subsequent studies of the public health impact of these vaccines have shown a beneficial effect. A prospective surveillance study ^[26] of RV coverage and efficacy at sentinel sites in Gauteng and Mpumalanga provinces, described a reduction of one-third in total diarrhoea admissions and 58% reduction in rotavirus-positive admissions two years after vaccine commencement. A study ^[25] of SA hospital data submitted through the District Health Information System (DHIS) described a 44% and 28% reduction in diarrhoea with dehydration and pneumonia incidence respectively in children under-5 between 2007 and 2012 and 40% reduction in CFR of both conditions. The same study reported – from data sourced from the Child Healthcare Problem Identification Programme (Child PIP) – more than 50% reduction in in-hospital mortality from both conditions during this period. ^[25] More recently, a multi-center matched case-control study concluded that the pneumococcal vaccine was effective in preventing disease in HIV-uninfected South African children. ^[27] Our findings demonstrate a similar trend in the incidence and mortality of severe

diarrhoea and pneumonia in children that coincides with the introduction of new vaccines and may be due to an actual decline in population incidence and reduced severity of disease as a result of increasing vaccine coverage. However, other factors such as improvements in access and treatment at lower levels of care, improvements in access to safe water and sanitation, better nutrition, better hygiene practices and others have contributed to such positive trends. ^[28] In addition, the recent decline in HIV transmission rates from mother-to-child in SA ^[29] and expansion of ART would impact on these diseases that occur commonly in the immune-compromised. Pneumonia and diarrhoea admissions in this study demonstrated distinct seasonal peaks that were consistent across a defined period. This finding is of particular interest from a health planning perspective, as health care services could be primed to cope with potential outbreaks during peak seasons.

In-hospital mortality at RCCH has declined consistently over a decade, mirroring the U5MR ^[3,4] as well as the national in-hospital mortality rate reported in the latest Child PIP publication. ^[30] The cause-specific analysis of mortality demonstrates that this trend is largely due to significant declines in diarrhoea and pneumonia deaths most prominent in the infant population. Deaths due to cardiac and circulatory congenital anomalies have also shown a sizeable reduction over a span of 6 years. This success is most likely due to recent innovations in cardiological interventions for the correction of congenital heart lesions, available at centres of excellence such as RCCH. ^[31] Of note too is the disappearance of TB as an important cause of death in children less than and older than 5 years. Studies have demonstrated a high co-infection rate with HIV in children with TB ^[32,33] and a higher mortality in HIV-infected children hospitalised with TB. ^[33] Our data show that HIV co-morbidity is declining, which is the most probable reason for the decline in TB admissions and mortality. Important preventable, non-infectious causes of death such as those due to injuries and burns are becoming more prominent with the decline of certain infectious causes of childhood mortality. Consequently, for further gains to be made in child mortality, these causes have to be addressed with equal vigour. The Western Cape mortality profile for 2012 reported that nearly 40% of all under-5 deaths occurred in the neonatal period. ^[34] RCCH does not have designated neonatal and obstetric services; however, in 2008, 14% of under-5 deaths were in neonates, which increased to 16% in 2013. The majority of neonatal deaths at RCCH were due to congenital

anomalies, ‘other perinatal conditions’ or sepsis, whereas in the Western Cape in 2012 they were due to prematurity, birth asphyxia and infections. ^[34]

4.2 Strengths and limitations

Electronic hospital databases that contain clinical information have been described as ‘a potential gold mine of information and knowledge’, ^[9] which this study has demonstrated in certain respects. Insights were gained into patient load over time, readmissions, and mortality indices that are indicators of health system functioning and provide guidance to allocate resources. The decreasing trend in mortality and possibly the decrease in hospital stay for general medical admissions suggests an improvement in quality of care. While a disproportionate increase in ward admissions implies an uneven increase in workload for the hospital, this information also indicates where extra staff and beds may be needed. The data also highlighted sustained downturns in pneumonia and diarrhoea admissions and HIV co-morbidity, which confirm the success of relevant public health programmes. Additionally, this study identified matters of interest to future planning such as the steady rise in burns and specialist medical admissions and the growing importance of injury-related admissions and deaths.

An important limitation of any database study is the potential for error in recorded data, or in the omission of data, which has implications for the reliability of results. ^[35] The quality of data in Clinicom has not been assessed for this study and therefore results should be interpreted with a degree of caution. Furthermore, we were unable to merge the two databases and therefore could not link admission and discharge information. Missing data was a problem in this dataset as primary diagnostic codes were poorly recorded in the first half of the decade; however, these records improved substantially thereafter. Since missing codes were more common among acute care admissions, associated diagnoses were probably underestimated in this assessment. Secondary diagnosis codes were largely absent from the database; considering that HIV infection appears to be strikingly under-reported we assume that this was due to omission, presumably due to these being admissions records. Therefore, HIV co-morbidity reported here warrants a fair amount of circumspection; nevertheless, the general decline in HIV-associated disease is consistent with the strengthening of PMTCT and ART programmes. Likewise, this limitation also

pertains to the assessment of diarrhoea and pneumonia, which occur commonly as co-morbid conditions, but were explored only as primary diagnoses.

A further limitation involves the ranking of common disorders where only first admissions were considered; this non-specific method of excluding readmissions for chronic conditions excluded all readmissions, even those admitted with new illnesses. This could affect the magnitude as well as the ranking of common diagnoses.

4.3 Generalisability of findings

Due to the diverse objectives of this study all results are not generalisable to a set population. RCCH policy is to provide services to children under the age of 13 years but a substantial proportion of admissions were older. They were not excluded from the analysis as they contributed to workload. Generalisability is more feasible when an analysis had clear age criteria such as the trend analysis of diarrhoea and pneumonia admissions in children under the age of five years. A caveat here though is that the neonatal population is not well represented due to the paucity of services available for this age group. Nevertheless, the results do provide insights into the health of the population RCCH serves even though it is not a population easily defined by rigid demographic criteria or geographic boundaries.

4.4 Recommendations

While the decrease in short-stay ward and Trauma Unit admissions suggests that less serious cases are being seen at lower levels of care, the decrease in length of stay in the general medical wards suggests an increase in unplanned and short stay admissions. We recommend an evaluation of admission source, admission thresholds and referral criteria to ascertain the need for clearer guidelines for patient management at primary care level and at RCCH.

As a reliable information system is essential for health system strengthening, we recommend a validation study of Clinicom, that the two databases be linkable, and that hospital staff responsible for data recording and data capture be informed about the need for precision in these tasks.

We recommend further study of burns, injuries and chronic illness admissions as they are increasing and requiring more of the hospital's resources. These and other findings of preventable conditions highlighted in this study – such as pneumonia and diarrhoea – could be used to shape policy on future prevention.

5. CONCLUSION

Hospital administrative databases are prone to error, but despite these inaccuracies they remain valuable data sources for high quality health information. We observed some promising trends of special significance for child health in SA. There has been a consistent decline in in-patient mortality across a decade at RCCH, which suggests a general decline in childhood mortality in the catchment population. In addition, two major causes of childhood illness, pneumonia and diarrhoea, demonstrate a downward trend. However, they remain important causes of morbidity in childhood and efforts to reduce their burden should continue unabated.

6. AUTHOR'S INFORMATION AND CONTRIBUTIONS

YI is currently a Master's student at the School of Public Health & Family Medicine at the University of Cape Town.

YI performed all the analyses in this study and drafted the manuscript.

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REFERENCES

1. Chopra M, Daviaud E, Pattinson R, et al. Saving the lives of South Africa's mothers, babies, and children: can the health system deliver? *Lancet* 2009; 374: 835 - 846. [http://dx.doi.org/10.1016/S0140-6736(09)61123-5]
2. Bamford L. Maternal, newborn and child health. In: Padarath A, English R, editors. South African health review 2012/13. Durban: Health Systems Trust; 2013: p. 49-66.
Available at <http://www.hst.org.za/publications/south-african-health-review-2012/13> (accessed 08 Nov 2014).
3. Sanders D, Bradshaw D, Ngongo N. The status of child health in South Africa. In: Kibel M, Lake L, Pendlebury S, et al. editors. South African Child Gauge 2009/2010. Cape Town: Children's Institute, University of Cape Town; 2010: 29 - 40.
Available at <http://www.ci.org.za> (accessed 26 June 2014).
4. Statistics South Africa. Millennium Development Goals, Country Report 2013. Pretoria: Statistics South Africa; 2013. p. 62-69. Available at: http://www.statssa.gov.za/wp-content/uploads/2013/10/MDG_October-2013.pdf (accessed 04 February 2015).
5. McKerrow N, Mulaudzi M. Child mortality in South Africa: using existing data. In: Fonn S, Padarath A, editors. South African Health Review 2010. Durban: Health Systems Trust; 2010. p. 59-71. Available at <http://www.hst.org.za/publications/876>.
6. Hall K, Nannan N, Sambu W. Children count – the numbers. In: De Lannoy A, Swartz S, Lake L, et al. editors. South African Child Gauge 2015. Cape Town: Children's Institute, University of Cape Town; 2015. p. 100-134. Available at <http://www.ci.org.za>.

7. Bryce J, Daelmans B, Dwivedi A, et al. Countdown to 2015 for maternal, newborn, and child survival: the 2008 report on tracking coverage of interventions. *Lancet* 2008; 371: 1247 - 1258.
8. Bhutta ZA, Chopra M, Axelson H, et al. Countdown to 2015 decade report (2000-10): taking stock of maternal, newborn, and child survival. *Lancet* 2010; 375: 2032 – 2044.
[[http://dx.doi.org/10.1016/S0140-6736\(10\)60678-2](http://dx.doi.org/10.1016/S0140-6736(10)60678-2)]
9. Safran C, Chute CG. Exploration and exploitation of clinical databases. *Int J Bio-Med Comp* 1995;39: 151-156.
[[http://dx.doi.org/10.1016/0020-7101\(94\)01094-h](http://dx.doi.org/10.1016/0020-7101(94)01094-h)]
10. Ben-Arieh, A. The child indicators movement: Past, present and future. *Child Indicators Research* 2007; 1(1): 3-16.
[<http://dx.doi.org/10.1007/s12187-007-9003-1>]
11. Chavez GF, Ellis AA. Pediatric hospital admissions for measles - Lessons from the 1990 epidemic. *West J Med* 1996;165: 20-25.
12. Hill AM. Trends in paediatric medical admissions. *Br Med J* 1989; 298:1479-1483.
[<http://dx.doi.org/10.1136/bmj.298.6686.1479>]
13. Saxena S, Bottle A, Gilbert R, et al. Increasing short-stay unplanned hospital admissions among children in England; time trends analysis '97-'06. *PloS ONE* 2009; 4(10):1-6.
14. Connors C, Millar WJ. Changes in children's hospital use. Statistics Canada, Health Reports 1999;11(2):9-19.
15. Macy ML, Stanley RM, Lozon MM, et al. Trends in high-turnover stays among children hospitalized in the United States, 1993-2003. *Pediatrics* 2009;123(3): 996-1002.
[<http://dx.doi.org/10.1542/peds.2008-1428>]

16. Myer L, Smith E, Mayosi BM. Medical inpatient mortality at Groote Schuur Hospital, Cape Town, 2002-2009. *S Afr Med J* 2013;103(1):28-31. [<http://dx.doi.org/10.7196/samj.6285>]
17. Zwi K, Pettifor J, Soderlund N, et al. HIV infection and in-hospital mortality at an academic hospital in South Africa. *Arch Dis Child* 2000; 83: 227-230. [<http://dx.doi.org/10.1136/adc.83.3.227>]
18. Zwi KJ, Pettifor JM, Soderlund N. Paediatric hospital admissions at a South African urban regional hospital: the impact of HIV, 1992-1997. *Ann Trop Paed* 1999;19: 135-142. [<http://dx.doi.org/10.1080/02724939992455>]
19. Meyers T, Dramowski A, Schneider H, et al. Changes in paediatric HIV-related hospital admissions and mortality in Soweto, South Africa 1996-2011: light at the end of the tunnel? *J Acquir Immune Defic Syndr* 2012; 60(5): 503-510.
20. Healthcare Cost and Utilization Project – United States. Clinical Classifications Software (CCS) for ICD-10-CM/PCS. 2014. Available at <https://www.hcup-us.ahrq.gov/toolssoftware/ccs10/ccs10.jsp> (downloaded 25 Dec 2014).
21. Western Cape Government. <https://www.westerncape.gov.za> (accessed 15 May 2015).
22. Hon KE, Nelson EAS. Gender disparity in paediatric hospital admissions. *Ann Acad Med Singapore* 2006;35:882 – 888.
23. Gissler M, Järvelin M-R, Louhiala P, et al. Boys have more health problems in childhood than girls: follow-up of the 1987 Finnish birth cohort. *Acta Paediatr* 1999;88:310 – 314. [<http://dx.doi.org/10.1111/j.1651-2227.1999.tb01102.x>]

24. Van den Bosch WJHM, Huygen FJA, van den Hoogen HJM, et al. Morbidity in early childhood: differences between girls and boys under 10 years old. *Brit J Gen Pract* 1992; 42: 366 – 369.
25. Madhi SA, Bamford L, Ngcobo N. Effectiveness of pneumococcal conjugate vaccine and rotavirus vaccine introduction into the South African public immunisation programme. *S Afr Med J* 2014;104(3):228-234. [<http://dx.doi.org/10.7196/SAMJ.7597>]
26. Msimang VMY, Page N, Groome MJ, et al. Impact of rotavirus vaccine on childhood diarrheal hospitalization after introduction into the South African public immunization program. *Pediatr Infect Dis J* 2013; 32:1359-1364. [<http://dx.doi.org/10.1097/inf.0b013e3182a72fc0>]
27. Madhi SA, Groome MJ, Zar HJ, et al. Effectiveness of pneumococcal conjugate vaccine against presumed bacterial pneumonia hospitalisation in HIV-uninfected South African children: a case-control study. *Thorax* 2015; 0: 1-7. [<http://dx.doi.org/10.1136/thoraxjnl-2014-206593>]
28. Liu L, Oza S, Hogan D, et al. Global, regional, and national trends of child mortality in 2000-13, with projections to inform post-2015 priorities: an updated systematic analysis. *Lancet* 2015; 385:430-40. [[http://dx.doi.org/10.1016/S0140-6736\(14\)61698-6](http://dx.doi.org/10.1016/S0140-6736(14)61698-6)]
29. Barron P, Pillay Y, Doherty T, et al. Eliminating mother-to-child HIV transmission in South Africa. *Bull World Health Organ* 2013;91:70-74. [<http://dx.doi.org/10.2471/BLT.12.106807>]
30. Harper K. An overview of Child PIP national data 2012-2013. In: Stephen CR, editor. *Saving Children 2012-2013 An eighth survey of child healthcare in South Africa*. Pretoria: Tshepesa Press; 2016. p 1-13. Available at <http://www.childpip.org.za> (accessed 11 October 2016).

31. Zühlke L, Mirabel M, Marijon E. Congenital heart disease and rheumatic heart disease in Africa: recent advances and current priorities. *Heart* 2013; 99:1554-1561.
[<http://dx.doi.org/10.1136/heartjnl-2013-304130>]
32. Hesseling AC, Cotton MF, Jennings T. High Incidence of Tuberculosis among HIV-Infected Infants: Evidence from a South African Population-Based Study Highlights the Need for Improved Tuberculosis Control Strategies. *Clin Infect Dis* 2009; 48: 108 – 114.
[<http://dx.doi.org/10.1086/595012>]
33. Madhi SA, Huebner, RE, Doedens L, et al. HIV-1 co-infection in children hospitalised with tuberculosis in South Africa. *Int J Tuberc Lung Dis* 2000; 4(5):448–454.
34. Groenewald P, Evans J, Morden E, et al. Western Cape Mortality Profile 2012. Cape Town: South African Medical Research Council, 2015. ISBN:978-1-920618-45-2.
35. O'Malley KJ, Cook KF, Price MD, et al. Measuring diagnoses: ICD code accuracy. *Health Services Research* 2005;40(5):1620-1639.
[<http://dx.doi.org/10.1111/j.1475-6773.2005.00444.x>]

Part IV

APPENDIX

APPENDIX A

Approval Letters

1. Ethics approval letter from the UCT HSF's Human Research Ethics Committee



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



Room E52-24 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6338 • Facsimile [021] 406 6411
Email: shuretta.thomas@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

17 November 2014

HREC REF: 764/2014

A/Prof L Myer
Public Health & Family Medicine
Level 5, Room 5.51
Falmouth Building

Dear A/Prof Myer

PROJECT TITLE: ADMISSION TRENDS AT RED CROSS CHILDREN'S HOSPITAL, CAPE TOWN: 2004-2013 (MMed candidate Dr Y Isaacs)

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

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

Approval is granted for one year until the 30th November 2015.

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

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

Please quote the HREC REF in all your correspondence.

We acknowledge that the student, Dr Yumnah Isaacs will also be involved in this study.

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

Yours sincerely

Signed

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637.

Institutional Review Board (IRB) number: IRB00001938

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP) and Declaration of Helsinki guidelines.

HREC 764/2014

2. Facility approval letter from the Hospital Research Review Committee of RCCH



Dr TA Blake
Manager: Medical Services
Email: thomas.blake@westerncape.gov.za
Tel: +27 21 658 5788 fax: +27 21 658 5166
30 JULY 2014

DR Y ISAACS

Dear Dr Y Isaacs,

RE: RESEARCH AT RED CROSS WAR MEMORIAL CHILDREN'S HOSPITAL

You may proceed with the study once Ethics approval has been obtained, and you submit proof thereof.

Yours faithfully,

DR T A BLAKE
CHAIRPERSON
HOSPITAL RESEARCH REVIEW COMMITTEE

APPENDIX B

Journal Manuscript Appendices

Supplementary Tables and Figures

Tables 4.1 – 4.4: Exploration of missing primary diagnosis codes between 2004 & 2013.

Table 4.1: Missing ICD-10 codes by Ward

	A7	B1	B2	ICU	C2	D1	D2	E1	E2	G1	RU	S11	TRAUMA
Admissions	26 524	3 470	3 455	4 700	9 405	13 174	21 243	7 282	9 116	11 902	25 653	61 587	18 025
ICD-10 codes	23 804	3 140	3 293	4 147	8 629	11 057	20 077	6 411	8 381	11 711	21 379	47 534	11 394
Missing ICD-10 codes (%)	2 720 (10)	330 (10)	162 (5)	553 (12)	776 (8)	2 117 (16)	1 166 (5)	871 (12)	735 (8)	191 (1.6)	4 274 (17)	14 053 (23)	6 631 (37)

Table 4.2: Age distribution of missing and non-missing ICD-10 codes

	Missing	Not missing
Age: median (IQR)	2.1 (0.7 – 5.8)	2.4 (0.8 – 6.1)

Table 4.3: Missing ICD-10 codes by Death

	Missing	Not missing	Total
Died n (%)	677 (25%)	2,057	2,734
Survived n (%)	33,902 (16%)	178,900	212,802

$X^2 = 156.289$ $p < 0.001$

Table 4.4: Missing ICD-10 codes by Sex

	Missing	Not missing	Total
Male n (%)	19,969 (16)	104,171	124,140
Female n (%)	14,585 (16)	76,709	91,294
Indeterminate n (%)	11 (24)	34	45
Missing Gender n (%)	14 (25)	43	57

Table 4.5: Description of ward sex and age distribution January 2004 – December 2013

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
General medical wards										
Age in years, median (IQR)	0.8 (0.3 – 2.2)	0.9 (0.3 – 3.2)	0.9 (0.3 – 3.6)	0.7 (0.3 – 2.3)	0.8 (0.3 – 2.5)	0.8 (0.3 – 2.0)	0.8 (0.3 – 2.6)	0.9 (0.3 – 3.2)	0.9 (0.3 – 3.6)	0.9 (0.3 – 3.2)
Female, n (%)	329 (44)	328 (47)	311 (49)	324 (46)	319 (48)	348 (47)	320 (46)	271 (46)	292 (44)	344 (44)
Short stay medical										
Age in years, median (IQR)	1.0 (0.4 – 2.2)	1.0 (0.4 – 2.3)	1.0 (0.4 – 2.2)	0.9 (0.4 – 2.1)	1.0 (0.4 – 2.3)	1.1 (0.4 – 2.6)	1.1 (0.4 – 2.6)	1.3 (0.5 – 3.0)	1.3 (0.5 – 3.1)	1.3 (0.5 – 3.1)
Female, n (%)	3 259 (43)	3 433 (45)	3 829 (44)	4 034 (44)	4 116 (43)	4 562 (44)	4 346 (44)	4 044 (44)	3 325 (44)	3 284 (43)
Medical										
Subspecialty										
Age in years, median (IQR)	5.1 (2.2 – 10.2)	5.4 (2.1 – 10.0)	5.1 (1.9 – 9.6)	5.3 (2.1 – 10.0)	5.2 (2.2 – 9.8)	4.7 (2.1 – 9.4)	4.7 (2.1 – 9.4)	5.1 (2.4 – 9.1)	5.6 (2.6 – 10.2)	5.6 (2.6 – 9.7)
Female, n (%)	989 (47)	1 084 (49)	1 198 (50)	1 185 (47)	1 233 (46)	1 405 (48)	1 269 (44)	1 561 (45)	1 544 (46)	1 611 (44)
Surgical wards										
Age in years, median (IQR)	3.2 (0.9 – 7.7)	3.1 (0.8 – 7.7)	3.2 (1.0 – 7.7)	2.9 (0.8 – 7.4)	3.0 (0.8 – 7.0)	3.3 (0.8 – 7.5)	3.4 (1.0 – 7.6)	3.6 (1.0 – 7.4)	3.7 (1.1 – 8.0)	3.9 (1.3 – 8.1)
Female, n (%)	1 285 (38)	1 301 (37)	1 356 (38)	1 333 (39)	1 221 (38)	1 256 (38)	1 197 (37)	1 369 (37)	1 304 (37)	1 366 (37)
Trauma Unit										
Age in years, median (IQR)	5.8 (3.1 – 8.8)	6.0 (3.3 – 8.9)	5.8 (3.0 – 8.8)	5.9 (3.0 – 8.7)	5.9 (3.3 – 8.6)	5.7 (3.2 – 8.5)	5.4 (3.0 – 8.4)	5.5 (2.7 – 8.1)	5.3 (2.8 – 8.0)	5.4 (2.9 – 8.4)
Female, n (%)	804 (38)	771 (37)	656 (33)	589 (36)	542 (34)	579 (36)	695 (38)	664 (37)	636 (37)	603 (36)
ICU										
Age in years, median (IQR)	0.4 (0.1 – 1.5)	0.3 (0.1 – 1.7)	0.3 (0.1 – 1.4)	0.3 (0.1 – 1.9)	0.3 (0.1 – 1.4)	0.3 (0.1 – 1.6)	0.4 (0.1 – 1.1)	0.3 (0.1 – 1.9)	0.3 (0.1 – 1.7)	0.4 (0.1 – 2.0)
Female, n (%)	219 (45)	178 (44)	170 (44)	182 (47)	202 (40)	219 (45)	246 (47)	198 (44)	235 (46)	235 (42)
Burns Unit										
Age in years, median (IQR)	2.3 (1.1 – 5.0)	2.2 (1.2 – 5.5)	2.0 (1.1 – 4.7)	1.9 (1.2 – 4.4)	1.7 (1.1 – 4.1)	1.8 (1.2 – 4.0)	1.8 (1.1 – 4.1)	2.1 (1.3 – 4.4)	2.1 (1.3 – 4.5)	2.0 (1.2 – 3.9)
Female, n (%)	304 (44)	340 (43)	397 (44)	436 (48)	365 (41)	372 (40)	465 (41)	420 (45)	455 (44)	547 (46)
Day Surgical										
Age in years, median (IQR)	5.0 (3.0 – 8.0)	5.2 (3.0 – 7.9)	5.1 (2.9 – 7.9)	5.2 (2.9 – 8.2)	4.7 (2.8 – 7.7)	4.6 (2.8 – 7.4)	4.6 (2.8 – 7.6)	4.6 (2.8 – 7.3)	4.6 (2.8 – 7.1)	4.7 (2.8 – 7.5)
Female, n (%)	1 124 (41)	1 164 (40)	1 328 (45)	1 106 (43)	1 019 (41)	1 087 (42)	1 021 (42)	1 047 (40)	1 074 (41)	1 115 (43)

Table 4.6: Deaths at RCCH by admission ward, 2004-2013

Ward n (% of all deaths)	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
General medical	73 (21)	90 (26)	75 (22)	74 (23)	56 (19)	54 (19)	54 (20)	36 (17)	29 (15)	19 (12)
Medical specialty	36 (11)	42 (12)	42 (13)	37 (12)	39 (14)	49 (17)	42 (16)	44 (21)	45 (24)	36 (23)
Short stay medical	90 (26)	97 (28)	103 (31)	82 (26)	61 (21)	58 (20)	53 (20)	32 (15)	17 (9)	20 (13)
Burns	3 (1)	3 (1)	6 (2)	9 (3)	4 (1)	2 (1)	5 (2)	1 (0.5)	5 (3)	3 (2)
Surgical wards	9 (3)	15 (4)	20 (6)	18 (6)	21 (7)	12 (4)	14 (5)	14 (7)	13 (7)	3 (2)
Trauma	17 (5)	19 (6)	15 (4)	20 (6)	22 (8)	14 (5)	10 (4)	14 (7)	14 (7)	11 (7)
ICU	114 (33)	80 (23)	73 (22)	76 (24)	86 (30)	97 (34)	86 (33)	70 (33)	67 (35)	64 (41)
Total	342 (100)	346 (100)	334 (100)	316 (100)	289 (100)	286 (100)	264 (100)	211 (100)	190 (100)	156 (100)

Table 4.7: Ranking of common medical conditions at RCCH by age category, 2008 & 2013

		2008					2013				
Age Category	Rank	Disorder	Frequency	Proportion of hospitalisation % (95% CI)	Age Category	Rank	Disorder	Frequency	Proportion of hospitalisation % (95% CI)		
< 1 year	1	Diarrhoea	1 563	40 (38-41)	< 1 year	1	LRTI	1 061	38 (37-40)		
	2	LTRI	1 383	35 (33-36)		2	Diarrhoea	715	26 (24-28)		
	3	Sepsis	194	5 (4-6)		3	Sepsis	204	7 (6-8)		
	4	Convulsions	119	3 (2-4)		4	Convulsions	90	3 (3-4)		
	5	Meningitis	105	3 (2-3)		5	COPD & Bronchiectasis	89	3 (3-4)		
Total (missing codes)			3 969 (84)					2 761 (22)			
1 – 5 years	1	Diarrhoea	826	36 (34-38)	1 – 5 years	1	Diarrhoea	609	30 (28-32)		
	2	LRTI	467	20 (18-22)		2	LRTI	414	20 (19-22)		
	3	Convulsions	253	11 (10-12)		3	Convulsions	214	11 (9-12)		
	4	Tuberculosis	106	5 (4-5)		4	Poisoning by meds/drugs	90	4 (4-5)		
	5	Poisoning by meds/drugs	106	5 (4-5)		5	Meningitis	70	3 (3-4)		
Total (missing codes)			2 323 (42)					2 023 (21)			
> 5 years	1	Convulsions	115	18 (15-21)	> 5 years	1	Diarrhoea	73	12 (10-15)		
	2	Diarrhoea	88	14 (11-17)		2	Convulsions	67	11 (9-14)		
	3	LRTI	85	13 (11-16)		3	Asthma	67	11 (9-14)		
	4	Tuberculosis	58	9 (7-12)		4	Meningitis	63	11 (8-13)		
	5	Asthma	49	8 (6-10)		5	LRTI	47	8 (6-10)		
Total (missing codes)			640 (14)					592 (5)			

Table 4-8: Ranking of common surgical conditions at RCCH by age category, 2008 & 2013

Age Category	2008					2013				
	Rank	Disorder	Frequency	Proportion of hospitalisation % (95% CI)	Age Category	Rank	Disorder	Frequency	Proportion of hospitalisation % (95% CI)	
< 1 year	1	Abdominal hernia	167	23 (20-27)	< 1 year	1	Abdominal hernia	130	20 (17-23)	
	2	Skin & subcut tissue infection	126	18 (15-21)		2	Other injuries dt external causes	86	13 (11-16)	
	3	Other injuries dt external causes	57	8 (6-10)		3	Skin & subcut tissue infection	71	11 (9-14)	
	4	Other congenital anomalies	50	7 (5-9)		4	Other congenital anomalies	40	6 (4-8)	
	5	Digestive congenital anomalies	36	5 (4-7)		5	Digestive congenital anomalies	34	5 (3-7)	
Total (m)			718 (46)				650 (16)			
1-5 years	1	Skin & subcut tissue infection	204	13 (11-14)	1-5 years	1	Other injuries dt external causes	304	16 (15-18)	
	2	Acute & chronic tonsillitis	191	12 (10-13)		2	Acute & chronic tonsillitis	181	10 (8-11)	
	3	Other injuries dt external causes	158	10 (8-11)		3	Skin & subcut tissue infection	170	9 (8-11)	
	4	Other eye disorders	90	6 (4-7)		4	Other eye disorders	104	6 (5-7)	
	5	Other congenital anomalies	89	5 (4-7)		5	Lower limb fracture	85	5 (4-6)	
Total (m)			1 622 (137)				1 858 (37)			
> 5 years	1	Upper limb fracture	246	13 (12-15)	> 5 years	1	Other injuries dt external causes	238	12 (11-14)	
	2	Other injuries dt external causes	157	9 (7-10)		2	Upper limb fracture	198	10 (8-12)	
	3	Acute & chronic tonsillitis	133	7 (6-9)		3	Acute & chronic tonsillitis	173	9 (8-10)	
	4	Skin & subcut tissue infection	130	7 (6-8)		4	Appendicitis & other appendiceal conditions	121	6 (5-7)	
	5	Lower limb fracture	118	6 (5-8)		5	Skin & subcut tissue infection	119	6 (5-7)	
Total (m)			1 836 (153)				1 941 (42)			

Table 4.9: Ranking of common causes of death at RCCH by age category, 2008 & 2013

2008					2013		
Age category	Cause of death	<i>f</i>	Proportion of deaths by age category % (95%)	Rank	Cause of death	<i>f</i>	Proportion of deaths by age category % (95%)
<1 year	Pneumonia	25	16 (11-23)	1	Sepsis	12	18 (10-29)
	Cardiac & circulatory congenital anomalies	21	14 (9-20)	2	Pneumonia	8	12 (5-22)
	Diarrhoea	16	10 (6-16)	3	Diarrhoea	5	7 (2-17)
	Sepsis	12	8 (4-13)	4	Cardiac & circulatory congenital anomalies	5	7 (2-17)
	Other perinatal conditions	10	6 (3-12)	5	Cardiomyopathy	3	4 (1-13)
Total deaths		155	(8 missing codes)			67	(1 missing code)
1-5 years	Pneumonia	10	14 (7-24)	1	Other injuries & conditions due to external causes	5	9 (3-20)
	Diarrhoea	9	12 (6-22)	2	Sepsis	4	7 (2-18)
	Tuberculosis	5	7 (2-15)	3	Pneumonia	4	7 (2-18)
	Cardio-myopathy	5	7 (2-15)	4	Diarrhoea	4	7 (2-18)
	Nutritional deficiencies	3	4 (1-12)	5	Other liver diseases	4	7 (2-18)
Total deaths		73	(3 missing codes)			55	(none missing)
>5 years	Pneumonia	7	11 (5-22)	1	Other injuries & conditions due to external causes	5	15 (5-31)
	Other injuries & conditions due to external causes	5	8 (3-18)	2	Burns	3	9 (2-24)
	Skull & face fractures	4	7 (2-16)	3	Non-hodgkin's lymphoma	2	6 (1-20)
	Burns	4	7 (2-16)	4	Paralysis	2	6 (1-20)
	Tuberculosis	3	8 (1-14)	5	Other nervous system disorders	2	6 (1-20)
Total deaths		61	(6 missing codes)			34	(1 missing code)

APPENDIX C

Journal submission guidelines

South African Medical Journal

Author Guidelines

Accepted manuscripts that are not in the correct format specified in these guidelines will be returned to the author(s) for correction, and will delay publication.

AUTHORSHIP

Named authors must consent to publication. Authorship should be based on: (i) substantial contribution to conception, design, analysis and interpretation of data; (ii) drafting or critical revision for important intellectual content; or (iii) approval of the version to be published. These conditions must all be met (uniform requirements for manuscripts submitted to biomedical journals; refer to www.icmje.org).

CONFLICT OF INTEREST

Authors must declare all sources of support for the research and any association with a product or subject that may constitute conflict of interest.

RESEARCH ETHICS COMMITTEE APPROVAL

Provide evidence of Research Ethics Committee approval of the research where relevant.

PROTECTION OF PATIENT'S RIGHTS TO PRIVACY

Identifying information should not be published in written descriptions, photographs, and pedigrees unless the information is essential for scientific purposes and the patient (or parent or guardian) gives informed written consent for publication. The patient should be shown the manuscript to be published. Refer to www.icmje.org.

ETHNIC CLASSIFICATION

References to ethnic classification must indicate the rationale for this.

MANUSCRIPTS

Shorter items are more likely to be accepted for publication, owing to space constraints and reader preferences.

Research articles (previously 'Original articles') not exceeding 3 000 words, with up to 6 tables or illustrations, are usually observations or research of relevance to clinical medicine and related fields. *References should be limited to no more than 15.* Please provide a structured abstract not exceeding 250 words, with the following recommended headings: *Background, Objectives, Methods, Results, and Conclusion.*

Scientific letters will be considered for publication as shorter **Research articles**.

Editorials, Opinions, etc. should be about 1000 words and are welcome, but unless invited, will be subjected to the *SAMJ* peer review process.

Review articles are rarely accepted unless invited.

Letters to the editor, for publication, should be about 400 words with only one illustration or table, and must include a correspondence address.

Forum articles must be accompanied by a short description (50 words) of the affiliation details/interests of the author(s). Refer to recent forum articles for guidance. Please provide an accompanying abstract not exceeding 150 words.

Book reviews should be about 400 words and must be accompanied by the publication details of the book.

Obituaries should be about 400 words and may be accompanied by a photograph.

Guidelines must be endorsed by an appropriate body prior to consideration and all conflicts of interest expressed. A structured abstract not exceeding 250 words (recommended sub-headings: *Background, Recommendations, Conclusion*) is

required. Sections and sub-sections must be numbered consecutively (e.g. 1. Introduction; 1.1 Definitions; 2. etc.) and summarised in a Table of Contents. References, appendices, figures and tables must be kept to a minimum.

Guidelines exceeding 8 000 words will only be considered for publication as a supplement to the SAMJ; the costs of which must be covered by sponsorship or advertising. The Editor reserves the right to determine the scheduling of supplements. Understandably, a delay in publication must be anticipated dependent upon editorial workflow.

MANUSCRIPT PREPARATION

Refer to articles in recent issues for the presentation of headings and subheadings. If in doubt, refer to 'uniform requirements' -www.icmje.org. Manuscripts must be provided in **UK English**.

Qualification, affiliation and contact details of ALL authors must be provided in the manuscript and in the online submission process.

Abbreviations should be spelt out when first used and thereafter used consistently, e.g. 'intravenous (IV)' or 'Department of Health (DoH)'.

Scientific measurements must be expressed in SI units except: blood pressure (mmHg) and haemoglobin (g/dl). Litres is denoted with a lowercase 'l' e.g. 'ml' for millilitres). Units should be preceded by a space (except for %), e.g. '40 kg' and '20 cm' but '50%'. Greater/smaller than signs (> and 40 years of age'. The same applies to \pm and $^{\circ}$, i.e. '35 \pm 6' and '19 $^{\circ}$ C'.

Numbers should be written as grouped per thousand-units, i.e. 4 000, 22 160...

Quotes should be placed in single quotation marks: i.e. The respondent stated: '...' Round **brackets** (parentheses) should be used, as opposed to square brackets, which are reserved for denoting concentrations or insertions in direct quotes.

General formatting The manuscript must be in Microsoft Word or RTF document format. Text must be single-spaced, in 12-point Times New Roman font, and contain no unnecessary formatting (such as text in boxes, with the exception of Tables).

ILLUSTRATIONS AND TABLES

If tables or illustrations submitted have been published elsewhere, the author(s) should provide consent to republication obtained from the copyright holder.

Tables may be embedded in the manuscript file or provided as '**supplementary files**'. They must be numbered in Arabic numerals (1,2,3...) and referred to consecutively in the text (e.g. 'Table 1'). Tables should be constructed carefully and simply for intelligible data representation. Unnecessarily complicated tables are strongly discouraged. Tables must be cell-based (i.e. not constructed with text boxes or tabs), and accompanied by a concise title and column headings. Footnotes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || then ** †† ‡‡ etc.

Figures must be numbered in Arabic numerals and referred to in the text e.g. '(Fig. 1)'. Figure legends: Fig. 1. 'Title...' All illustrations/figures/graphs must be of **high resolution/quality**: 300 dpi or more is preferable, but images must not be resized to increase resolution. Unformatted and uncompressed images must be attached individually as '**supplementary files**' upon submission (not solely embedded in the accompanying manuscript). TIFF and PNG formats are preferable; JPEG and PDF formats are accepted, but authors must be wary of image compression. Illustrations and graphs prepared in Microsoft Powerpoint or Excel must be accompanied by the original workbook.

REFERENCES

References must be kept to a maximum of 15. Authors must verify references from original sources. *Only complete, correctly formatted reference lists will be accepted.* Reference lists must be generated manually and **not** with the use of

reference manager software. Citations should be inserted in the text as superscript numbers between square brackets, e.g. These regulations are endorsed by the World Health Organization,^[2] and others.^[3,4-6] All references should be listed at the end of the article in numerical order of appearance in the **Vancouver style** (not alphabetical order). Approved abbreviations of journal titles must be used; see the List of Journals in Index Medicus. Names and initials of all authors should be given; if there are more than six authors, the first three names should be given followed by et al. First and last page, volume and issue numbers should be given.

Wherever possible, references must be accompanied by a digital object identifier (DOI) link and PubMed ID (PMID)/PubMed Central ID (PMCID). Authors are encouraged to use the DOI lookup service offered by [CrossRef](#).

Journal references: Price NC, Jacobs NN, Roberts DA, et al. Importance of asking about glaucoma. *Stat Med* 1998;289(1):350-355.
[<http://dx.doi.org/10.1000/hgjr.182>] [PMID: 2764753]

Book references: Jeffcoate N. Principles of Gynaecology. 4th ed. London: Butterworth, 1975:96-101. *Chapter/section in a book:* Weinstein L, Swartz MN. Pathogenic Properties of Invading Microorganisms. In: Sodeman WA jun, Sodeman WA, eds. Pathologic Physiology: Mechanisms of Disease. Philadelphia: WB Saunders, 1974:457-472.

Internet references: World Health Organization. The World Health Report 2002 - Reducing Risks, Promoting Healthy Life. Geneva: World Health Organization, 2002. <http://www.who.int/whr/2002> (accessed 16 January 2010).

Other references (e.g. reports) should follow the same format: Author(s). Title. Publisher place: publisher name, year; pages. Cited manuscripts that have been accepted but not yet published can be included as references followed by '(in press)'. Unpublished observations and personal communications in the text must not appear in the reference list. The full name of the source person must be provided for personal communications e.g. '...(Prof. Michael Jones, personal communication)'.

PROOFS

A PDF proof of an article may be sent to the corresponding author before publication to resolve remaining queries. At that stage, **only** typographical changes are permitted; the corresponding author is required, having conferred with his/her co-authors, to reply within 2 working days in order for the article to be published in the issue for which it has been scheduled.

CHANGES OF ADDRESS

Please notify the Editorial Department of any contact detail changes, including email, to facilitate communication.

CPD POINTS

Authors can earn up to 15 CPD CEUs for published articles. Certificates may be requested after publication of the article.

CHARGES

There is no charge for the publication of manuscripts.

Please refer to the section on '*Guidelines*' regarding the publication of supplements, where a charge may be applicable.

Submission Preparation Checklist

As part of the submission process, authors are required to check off their submission's compliance with all of the following items, and submissions may be returned to authors that do not adhere to these guidelines.

1. Named authors consent to publication and meet the requirements of authorship as set out by the journal.
2. The submission has not been previously published, nor is it before another journal for consideration.
3. The text complies with the stylistic and bibliographic requirements in [Author Guidelines](#).
4. The manuscript is in Microsoft Word or RTF document format. The text is single-spaced, in 12-point Times New Roman font, and contains no unnecessary formatting.
5. Illustrations/figures are high resolution/quality (not compressed) and in an acceptable format (preferably TIFF or PNG). These must be submitted individually as 'supplementary files' (not solely embedded in the manuscript).
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