The changing trends in paediatric hospital admissions at Chris Hani Baragwanath Hospital 1992 - 1997

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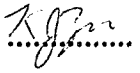
DECLARATION

I, Karen Joy Zwi, declare that this research report is my own work. It is being submitted in partial fulfilment of the Degree of Master of Medicine (Paediatrics) in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or any examination at this or any other University.



20th day of March, 1998

ABSTRACT

Introduction: Rates of infection with the Human Immunodeficiency Virus (HIV) have been increasing steadily in South Africa over the last decade. The focus of this study is to determine the changes over time in prevalence of HIV infection amongst hospitalised children, and its effects on the profile of disease and in-hospital mortality over the time period 1992 to 1997.

Methods & Analysis: The routine computerised database held in the Department of Paediatrics at Chris Hani Baragwanath Hospital was used. Subjects included admissions to the paediatric medical wards between 1st January 1992 and 30th April 1997. HIV results are available only for patients who have been tested, with informed consent, for clinical indications.

Results: Records were available for 22 635 admissions involving 19 918 children. Total annual admissions increased by 23.6% between 1992 and 1996. Prevalence of HIV infection increased from 2.9% in 1992 to 20% in 1997. HIV infected children had a younger age distribution ($p<0.001$) and longer median length of stay ($p<0.001$) compared with HIV negative and untested children. HIV infection accounted for a disproportionate number of admissions for pneumonia ($p<0.001$), gastro-enteritis ($p<0.001$), malnutrition ($p<0.001$) and tuberculosis ($p<0.001$), and accounted for the rise in absolute numbers of admissions for these diagnoses. HIV negative children showed declining rates of malnutrition, vaccine-preventable

diseases and admission to the Intensive Care Unit ($p<0.001$) over the study period.

In-hospital mortality for all children increased by 42% from 4.3% in 1992 to 6.1% in 1997. Mortality was 13.2% in the HIV infected children compared to 5.1% in uninfected children and 3.1% in untested children ($p<0.001$). Mortality rates in uninfected children declined over time from 5.3% in 1992 to 4.6% in 1996 ($p=0.06$). The proportion of all deaths that were HIV positive increased from 6.7% in 1992 to 54.3% in 1997 ($p<0.001$). The most common causes of death were pneumonia (24.6%), septicaemia (12.2%) and gastro-enteritis (9.5%) for all children, with pneumonia assuming a greater proportion in the HIV infected group (52.8%) ($p<0.001$).

Conclusion: Paediatric HIV infection has changed the profile of paediatric admission diagnoses and increased in-hospital mortality in the relatively short time period between 1992 and 1997. The trends seen in this study are expected to continue well into the future and should be taken into consideration in planning staffing and health service funding in the future.

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1. INTRODUCTION

1.1 Background to Chris Hani Baragwanath Hospital

Chris Hani Baragwanath Hospital, formerly Baragwanath Hospital, is the largest hospital on the African continent and one of the largest in the world. It is one of the 40 provincial hospitals financed and run by the Gauteng health authorities. It serves a community of approximately 3 million people, has more than 3 000 beds and over 7 000 members of staff. It is the largest of the teaching hospitals used for the training of medical students from the University of the Witwatersrand. In the one year period between July 1995 and June 1996[1], the hospital attended to 1 445 060 outpatients and 106 272 patients were admitted.

The hospital serves the community of Soweto, south-west of central Johannesburg Prior to the desegregation of hospitals, Chris Hani Baragwanath Hospital was the major referral hospital for black patients in southern Gauteng and also served Soweto as a regional or community hospital. Since desegregation, the hospital now formally acts as the tertiary referral hospital for a similar area, but continues to see predominantly black patients because of patient demographics. As a tertiary referral service, a range of subspecialty services are provided.

Soweto is comprised of both wealthy sectors and extremely impoverished squatter sections. Twelve percent of the local community belong to a medical aid scheme; these patients are officially permitted to utilise the outpatient facilities only. Antenatal care and medical treatment for children under the age of six years is free.

The Paediatric Department of the hospital deals with all medical and neonatal paediatric patients. Paediatric surgical specialties are managed separately by the Surgery Department and include Paediatric Surgery, Otorhinolaryngology, Neurosurgery, Orthopaedics and Burns Unit. Medical and neonatal patients may be seen as general outpatients in the Paediatric Outpatient Department, which also serves as a Paediatric Casualty, or as follow-up or referral patients in the follow-up clinics or special clinics, such as Neurology and Cardiology. The Paediatric Outpatient Department has been seeing approximately 50 000 patients per year since 1992, that is about 140 patients per day. There have been approximately 15 000 specialist referral and follow-up consultations per year since 1992.

Patients requiring admission may be admitted to several places: the Neonatal Unit, the Intensive Care Unit, the general paediatric wards, the specialist Haematology-Oncology ward, the Gastro-enteritis Unit or the "Sleepover" ward. The Gastro-enteritis Unit is for children who have uncomplicated gastro-enteritis requiring rehydration and observation, and usually admits about 1 200 patients per year. Those with general paediatric problems who are not very ill and not clinically malnourished can be admitted to the "Sleepover" ward, where they can stay for up to four days. This

would include children with bronchopneumonia who ld respiratory distress or children with suspected pyrexial convulsions requiring vation. This ward has admitted between 4 100 and 5 800 patients per year since 1992, approximately equal to the numbers admitted to the general paediatric wards.

There are four general paediatric wards. Subspecialist patients, such as those with renal or cardiac problems, are admitted to these wards and managed in consultation with the relevant subspecialist. The Haematology-Oncology, Neonatal and Intensive Care Units are separate units with dedicated staff.

1.2 The disease profile of paediatric hospital admissions

The most common reasons for childhood admissions to hospital in less developed countries are malaria, pneumonia, gastro-enteritis and measles[2,3,4,5]. Studies in South Africa have shown similar profiles although with trauma assuming greater significance and malaria varying with geographical area. Pneumonia, gastro-enteritis and trauma were the most common causes for paediatric admission to Gelukspan Hospital, North West Province in 1994[6] and Murchison Hospital, rural Natal in 1991[7]. The most common causes for admission to Chris Hani Baragwanath Hospital in 1996 were pneumonia (1 674 children), gastro-enteritis (1 069), HIV-disease (876) and septicaemia (381). There were 75 cases of malaria, more than double the 30 cases seen in 1993 (UK Kala, unpublished data).

In Africa, acute respiratory infections (mostly pneumonia) are the leading cause of utilisation of paediatric health services, accounting for 20-40% of outpatient clinic visits and 12 - 35% of hospital admissions[8].

In less developed countries and in South Africa, immunisation-preventable disease constitutes a greater proportion of admissions as compared with developed countries. Measles accounted for 342 admissions to Chris Hani Baragwanath in 1989, but has declined to much lower levels more recently (49 in 1996) (UK Kala, unpublished data) Measles has been a problem in areas of low immunisation uptake in parts of South Africa[9]. In 1996, 9 340 cases of measles were reported in the country[10]. In 1988 a whooping cough epidemic was responsible for the admission of 292 children to hospital in Cape Town[11]. Although decreasing in incidence, neonatal tetanus continues to occur in informal settlements and rural areas of South Africa[12].

Immunisation coverage varies enormously by geographical area. Estimated DPT (diphtheria-pertussis-tetanus) coverage in 1991 was 7% in KwaNdebele as compared with 100% in Natal; a similar distribution existed for measles[13].

Infectious diseases such as tuberculosis (51 302 cases), malaria (19 753), viral hepatitis (823), typhoid fever (328) and meningococcal disease (257) were reported in large numbers in South Africa in 1997[10].

Malnutrition remains common in areas of South Africa. 33.5% of total admissions to Chris Hani Baragwanath Hospital in 1996 were below the 3rd centile for weight for age (UK Kala, unpublished data). Another disease associated with poor socio-economic conditions, paraffin ingestion, is still an important cause of hospitalisation in rural areas and constituted 9.1% of total ward admissions in under 5 year-olds at Shongwe Mission Hospital in 1997[14].

In developed countries, the profile of paediatric admissions has changed. Infectious diseases and diseases of poverty have largely been replaced by chronic diseases of childhood. Those children admitted with infectious disease, such as gastro-enteritis, have mild disease[15] and tend to come from socially disadvantaged families (62% from social classes IV and V in a study in England)[16]. Chronic disease is far more important in the utilisation of health services in the developed world. In an urban paediatric hospital in Chicago, 24% of emergency department visits were by children with one or more chronic conditions; asthma comprised 43% of these visits[17].

Asthma is the most common chronic disease in the developed world, comprising 16% of paediatric admissions in a district general hospital in England[18]. Data from England, Sweden, Finland, New Zealand and elsewhere suggest a rise in the incidence of asthma in developed countries, with rising hospital admission rates in England and Wales and increasing asthma mortality in several countries[19].

The pattern of diagnoses in hospitalised children at Chris Hani Baragwanath Hospital has changed considerably since 1987, with reduced numbers with malnutrition, rheumatic heart disease and measles and its complications (UK Kala, unpublished data). The numbers with gastro-enteritis, pneumonia and septicaemia have increased, probably as a result of increasing numbers of children infected with HIV. At the same time there have been increasing numbers of children admitted for epilepsy and cerebral palsy. In Cape Town there has been an increase in paediatric admissions for asthma over the period 1978 to 1990, in line with trends elsewhere in the world[20] These trends may indicate that the childhood population admitted to these hospitals (excluding those infected with HIV) is beginning to present with a spectrum of disease more comparable with the developed world than previously.

Furthermore, general improvements in the nutritional status of children have been documented over the last decades in South Africa. In serial community health surveys in Mpumulanga, low weight-for-age fell from 28% in 1980 to 19% in 1990, low height-for-age from 33% to 17% and low weight-for-height from 5% to 1% over the ten years[21]. At Chris Hani Baragwanath Hospital, the proportion of admitted children who were malnourished fell from 38.9% in 1979 to 17.5% in 1987, although this has subsequently risen as a result of HIV disease (UK Kala, unpublished data).

1.3 The epidemiology of Human Immunodeficiency Virus (HIV) infection

In South Africa there are an estimated 2.5 million people currently infected with HIV, including 157 272 infected babies born since 1990. At the end of 1996, 14.2% of

pregnant women who attend antenatal clinics of the public health services were HIV positive. There were considerable geographical variations within the country: antenatal clinics with seroprevalence below 10% were the Western Cape at 3.1%, Northern Cape at 6.5%, Northern Province at 7.7% and the Eastern Cape at 8.1%. In the rest of the provinces, rates were above 15%, with Gauteng at 15.5% and Kwazulu-Natal, the highest, at 19.9%[22].

HIV infection is not homogeneously spread *within* the provinces. In Gauteng, for example, Randfontein/Westonaria and East Rand had prevalences over 20% whilst Pretoria/Bronkhoorspruit had 3.7%[22]. Seroprevalence among Chris Hani Baragwanath antenatal clinic attenders in 1997 was 18%[23], a striking increase from the 0.82% recorded in 1990[24].

The age distribution was also heterogeneous. Women in their twenties had the highest rates of HIV infection at 17.7% and 15.3% for the 20-24 and 25-29 year-old groups respectively[22]. This is also the group with the highest fertility rate[10] and therefore at greatest risk of producing children infected and affected by HIV. Vertical transmission is estimated to be between 26% and 42% in South Africa[25]. Not surprisingly, HIV infection in children has increased dramatically since 1990. In 1990 there were 51 children diagnosed with HIV infection admitted to the paediatric medical wards at Chris Hani Baragwanath Hospital[24], as compared with 497 in 1996 (UK Kala, unpublished data).

Based on the rate of annual growth, it is thought that South Africa is still experiencing a fast growing epidemic with continued increases expected in the years to come[22].

Around the world, 30 million people are thought to have been infected with HIV since the start of the epidemic, the majority of whom live in sub-Saharan Africa. This has taken its toll on life expectancy, created many AIDS orphans and has been a major burden on health services. In east Africa, HIV infection and AIDS account for more than 50% of adult medical admissions in some hospitals and 10-15% of paediatric admissions[26].

Several studies in Africa have documented the prevalence of HIV infection in hospitalised children, and their presenting diagnoses. In a teaching hospital in Nigeria 10% of paediatric admissions were screened for HIV infection between September 1992 and September 1994. Almost 9% were found to be definite positives on ELISA and Western Blot testing and 5% were indeterminate[5]. In 1991-1992 in Abidjan, Cote d'Ivoire, prevalence of HIV infection in 4 480 children hospitalised for the first time was 8.2%[27]. Much higher rates of HIV infection were found in Zambia as early as 1990 and 1991, where 28% of all paediatric admissions were found to be infected[4]. In South Africa high rates of HIV infection were documented at King Edward VIII Hospital in 1995 - 28% of children tested on clinical grounds and 32.6% of children who were routinely screened[28]. In a recent prospective study conducted at Chris Hani Baragwanath Hospital between June and December 1996, 92.7% of children (those giving informed consent) admitted to one of the four paediatric medical wards were

screened for HIV. 28% of these children were found to be infected with HIV (T Meyers, unpublished data).

Children infected with HIV present with common childhood illnesses[27], but have more severe illness and require more frequent hospitalisation[29,30]. The most common admission diagnoses in HIV infected children in the Zambian[4] and Cote d'Ivoire[27] studies were respiratory infection (26-28%), malnutrition (18-25%), malaria (24%), diarrhoea (10%), tuberculosis (5%) and meningitis. In the Zambian study, 69% of children with tuberculosis and 41% of those with malnutrition had HIV infection[4]. Multiple diagnosis (>3) on admission was significantly associated with HIV infection in the Nigerian study[5]. In the Chris Hani Baragwanath study, the most frequent admitting diagnosis was pneumonia, 66% of HIV infected children were malnourished and infected children were significantly more likely to be readmitted. Even in developed countries, children with HIV infection are more likely to be admitted to hospital, require intensive care facilities and to present with pneumonia and diarrhoea as compared with their uninfected counterparts[30].

The increase in HIV seroprevalence has been associated with an increase in the incidence of tuberculosis in South Africa[31] and elsewhere in the world[26,29,32]. In a district of rural Kwazulu-Natal, the incidence of tuberculosis in the adult population (above 14 years old) increased from 154/100 000 in 1991 to 413/100 000 in 1995, with the proportion of tuberculosis cases attributable to HIV infection estimated at 44% in 1995[33].

In a prospective study at Chris Hani Baragwanath Hospital conducted from July 1996 to January 1997, 46.3% of children with pulmonary tuberculosis were found to be co-infected with HIV. These children were much less likely to mount any response to intradermal tuberculin antigen testing, which contributes to the difficulty in making the diagnosis of tuberculosis in HIV infected children (S Madhi, unpublished data).

1.4 Paediatric mortality

1.4.1 Infant mortality rates, under-five mortality rates and causes of death

In South Africa infant mortality rates have fallen steadily over the time period 1929 - 1983. However there have been disparate gains in the different population groups, with infant mortality rates in white children falling from 64/1 000 to 13/1 000, and that in 'coloured' children from 158/1 000 to 55/1 000[34]. Between 1929 and 1983 the mortality rates for infectious causes fell dramatically in white children but much less so in 'coloured' children. True mortality rates in black children were uncertain during this time period.

Overall the infant mortality rate (IMR) in South Africa in 1994 was 52/1 000[35], with considerable racial and geographical variation. In the Western Cape Province in 1993, the highest IMR was amongst the 'coloured' population living in informal settlements (60; 95% CI 43-82), an IMR comparable to that in Kenya, Namibia and Senegal in 1994. For black children in informal settlements the IMR was lower (35; 95% CI 29-

40), and in whites it was 11 (95% CI 9-14)[36], comparable to IMRs in Malaysia, Croatia and Kuwait in 1994 but considerably higher than countries with the lowest IMRs in the world - Sweden, Finland and Japan with IMRs of 4/1 000 in 1994[35]. IMR for black children was reported to range from 30 to 73/1 000 in the former "homeland" areas according to 1993 government statistics, with marked improvement from the 154/1 000 reported in 1950[15].

The causes of death in the first year of life differed between population groups: in white children perinatal and congenital causes were most common, as in the developed world, whilst in 'coloured' children infections, perinatal and respiratory causes most commonly resulted in infant death. Measles, tuberculosis and syphilis remained important contributors to infant mortality in 'coloured' children in 1983, despite declines since 1929[37].

By 1985 in Cape Town[8], pneumonia had become a more important cause of death among white and 'coloured' children than diarrhoea; it ranked with diarrhoea as a cause of death in black children. Mortality rates for pneumonia declined by 50% over the period 1968 - 1985 in whites, 'coloureds' and Asians, though for all groups remained higher than rates recorded in Western European countries. In 1984 27.7% of deaths in under 5 year-olds were due to diarrhoea, with children under the age of one year at highest risk. Over the period 1968 - 1985 there were steady declines in diarrhoeal disease mortality rates of white, 'coloured' and Asian children, but accurate rates were not available for black children[38].

Infant mortality rates and the main causes of death are affected by the urban, peri-urban or rural location of the children involved. In 1980, children in urban areas outside of Soweto had infant mortality rates three times higher than in Soweto itself. Gastro-enteritis was the leading cause of death outside Soweto and had a mortality rate ten times higher than in Soweto, where it ranked third after perinatal and ill-defined causes of death. Perinatal causes and pneumonia were the second and third most important causes of death in rural children[39].

In greater Johannesburg in 1993, infant mortality rates were 4.5/1 000 and mortality rates in children aged one to four years were 0.8/1 000. The leading causes of infant death beyond the neonatal period were pneumonia, accidents and congenital anomalies. Diarrhoeal disease was not a major cause of death. In children aged one to four years, accidents and motor vehicle accidents accounted for 54.8% of deaths, followed by ill-defined and unknown causes (12.9%) and pneumonia (6.5%)[40].

Under five mortality rates have been declining in all racial groups in South Africa since 1978. Highest rates in 1990 were for "coloured" children (49/1 000), but this may reflect the problem of under-reporting in black children (20/1 000). The main causes of death in 1990/1991 were perinatal causes (33%), diarrhoeal disease (17%) and acute respiratory disease (9%)[13].

1.4.2 In-hospital mortality

Mortality amongst paediatric admissions at Chris Hani Baragwanath has fallen from 8.2% in 1977 to a nadir of 3.9% in 1992 with a subsequent steady climb to reach 6.1% in 1996. 42.5% of deaths in 1996 was as a result of HIV infection and its complications. Nevertheless, the main causes of death have not changed at Chris Hani Baragwanath Hospital since 1990 and include malnutrition, pneumonia, gastro-enteritis and septicaemia. Measles, which ranked with gastro-enteritis as an important cause of death in 1989, has been responsible for only 3 deaths since 1992 (UK Kala, unpublished data).

In-hospital mortality declined at Gelukspan hospital between 1979 and 1984. Risk of death in patients under five years decreased from 47.5% in 1979 to 9.5% in 1984. The main causes of death were diarrhoea, malnutrition and respiratory infections[6]. Mortality at King Edward VIII Hospital, Durban, was 18% ten years ago but has been steadily declining since. At Somerset Hospital in Cape Town, mortality in hospitalised children was 5% in 1996[28].

Much higher in-hospital mortality rates have been recorded from elsewhere in Africa[11]. As many as 30% of 0 to 2 year-olds admitted to the National Hospital in Niamey, Niger died, but this may be explained by the high prevalence of malnutrition (76%) in these children[12].

HIV infected children have consistently higher in-hospital mortality as compared with HIV negative children. In the Zambian[4] and Cote d'Ivoire[27] studies mentioned above (1990 and 1991/2 respectively), in-hospital mortality rates were similar at 19-20% in HIV positive children compared with 8.7-9% in HIV negative children. The rates for HIV negative children are comparable to those at Chris Hani Baragwanath Hospital in the 1970s. At Chris Hani Baragwanath in 1996, mortality in HIV uninfected children was 5% compared with 11% in infected children (T Meyers, unpublished data).

Case fatality rates vary depending on the study population and the type of hospital Between 1975 and 1990, case fatality rates for gastro-enteritis ranged from 1.9% in Ghana to 4.7% in Zambia, and for pneumonia, from 1.9% in Tanzania to 7.4% in Ghana[3]. In a Nigerian teaching hospital, cases fatality rates were as high as 13% for gastro-enteritis and 18% for pneumonia. Highest case fatality rates were documented for measles (32.6%), followed by marasmus, kwashiorkor and marasmic-kwashiorkor (27.3%)[41].

In parts of the less developed world, in-hospital paediatric mortality rates have been falling over the last decades, although the impact of HIV infection on mortality rates has yet to be documented. At the University College Hospital in Nigeria, paediatric mortality declined steadily from 208 per 1 000 admissions in 1978 to 179 per 1 000 in 1986. Reductions in gastro-enteritis and bronchopneumonia as causes of death were largely responsible for this decline[41]

1.5 Motivation for this study

At Chris Hani Baragwanath Hospital, no formal study has been performed to date to document the effect of the rising incidence of paediatric HIV infection on paediatric admissions. The objectives of this study were ascertain the HIV seroprevalence in hospitalised children over the study period, to determine the profile of hospital admissions and establish whether any changes over time had occurred, and to determine the impact of HIV disease on paediatric in-hospital mortality. In addition, the study aimed to assess whether health trends in those children not infected by HIV had improved over time.

2. METHODOLOGY

2.1 Study population

The study population included all children entered onto the computerised dataset as admissions to the General Paediatric wards (Wards 17,18,19 and 33) and the Paediatric Haematology/Oncology Unit at Chris Hani Baragwanath Hospital between January 1st 1992 and April 30th 1997. The study population specifically excluded admissions to the Neonatal Unit, Gastro-enteritis Unit or "Sleepover" Unit

2.2 Data Source

Patient information was obtained from the computerised dataset in the Department of Paediatrics at Chris Hani Baragwanath Hospital and stored as a DBase file. As part of ward routine, a discharge summary is completed by the doctor or medical student responsible for the child when that child is discharged, is transferred out of the general wards, or dies. The summary sheet contains the following information about each admission:

- name
- hospital number
- age
- gender
- area of residence
- nutritional status

dates of admission, discharge or death

primary and secondary diagnoses with ICD 9 codes

transfer to the Intensive Care Unit

The ward clerk gives a copy of this summary to a departmental clerk, who enters the data onto the computer database. These data were downloaded onto the researcher's personal computer.

2.3 HIV tests

Two data sources were used to ascertain the HIV status of the child:

(i) the hospital dataset containing discharge summary sheet information, where HIV status may be included as part of the diagnostic information. Since HIV status is not specifically requested it may be under-reported and the second data source was used to validate this data

(ii) the South African Institute for Medical Research (SAIMR), the only laboratory used by the Department of Paediatrics. Results of all HIV tests performed on children between January 1st 1992 and September 30th 1996 were obtained from this laboratory on a computer disc. Unfortunately the data beyond September 1996 were not available to the researcher at the time of writing up this report.

2.3.1 Definitions pertaining to HIV status

HIV positive refers to a child who was tested and was found to be infected with the Human Immunodeficiency Virus At Chris Hani Baragwanath Hospital, if two HIV ELISA tests were positive in a child above fifteen months of age, then the child was considered to be infected. For children under the age of fifteen months, maternal antibody may be picked up by the HIV ELISA test and the child was considered infected only there were clinical signs to suggest HIV infection. In 1992 and 1993, Western Blot tests were performed on all equivocal and positive HIV ELISA tests; this test was considered to reflect the correct result (H Crewe-Brown, personal communication).

HIV negative refers to a child who was tested and was found not to be infected with HIV, that is the ELISA test was negative. Those children who are born to HIV infected mothers may not be infected themselves and this becomes evident as they lose maternal antibody by the age of fifteen months.

Untested refers to children who have never had an HIV test. The HIV status was only assessed if the child's clinical picture was suggestive of HIV infection and if the care-giver gave informed consent. Few care-givers refused although the actual number of those refusing is not known

Computerised data with the SAIMR HIV results were merged with the hospital dataset on the basis of hospital number, identifying children with positive and negative HIV tests. Where a number of conflicting HIV results were obtained, the latest test was used as the correct result; for example several positive test results followed by a negative test result was regarded as a negative result as it is likely to represent the decline of maternal HIV antibody in a child who is truly HIV negative.

To ensure that no child was identified incorrectly as being HIV positive due to another patient having the identical hospital number, the date of the HIV test was required to fall between the date of admission and one month after discharge. In those children whose tests did not fulfil these criteria, the names were checked by hand and the results only accepted if the names in the two datasets corresponded.

A "best estimate" of HIV status was made by combining the final results from the SAIMR and the ward HIV diagnosis entered onto the discharge summary sheet. If either the latest SAIMR test was positive or the discharge summary recorded the child as positive, then the child was classified as HIV positive on the "best estimate" of HIV status. If children were identified as HIV positive in an admission that was not their first, this HIV status was allocated to them for all previous admissions as it is unlikely that these were acquired HIV infections.

To simplify the presentation of data, and to highlight the impact of HIV-related disease, HIV negative and untested children are grouped together as distinct from HIV

positive children. This is also the most accurate way of differentiating the infected group from the remainder of admissions since the "best HIV estimate" is influenced largely by the ward HIV status, and this identified only the HIV positive child without information as to whether the child was tested or not with a possible negative result.

2.4 Ethical considerations

The study was reviewed and approved by the University of the Witwatersrand's Committee for Research on Human Subjects (M 970932). All HIV tests performed on children were done with informed consent from the primary care-giver. In order to maintain patient confidentiality the patient's name was removed from the dataset once the two datasets were merged. The patient's hospital number was encrypted and retained as a unique identifier to ensure that repeated admissions of the same patient could be identified. No-one apart from the researcher would be able to trace the original hospital number and thus identify the patient.

2.5 Analysis

The data were analysed using computer programme SPSS[13]. General characteristics of the whole admission population are described and then interesting features about age distribution, trends in diagnoses, length of hospital stay, admission to the Intensive Care Unit, nutritional status and mortality statistics are highlighted and comparisons made between HIV positive, negative and untested children.

Only the most common diagnoses, such as pneumonia and gastro-enteritis are discussed in any detail.

When an analysis required children rather than admission as the unit of analysis, the data were aggregated on the basis of hospital number and analysed at the level of the individual. Comparisons between groups and distributions were made using appropriate statistical methods: χ^2 tests, one way analysis of variance (t-tests) and the generalised linear ANOVA model. Trends over time were analysed using the χ^2 test for trend.

2.6 Validation of data source

The completeness of the dataset was checked against the aggregate annual admission data available in each ward. This was compiled from monthly manual collection of admission date, diagnosis and discharge or death date and is currently available from 1992 to 1996.

The validity of the HIV estimate was checked against a study performed in one of the general wards (Ward 17) where almost all children were screened for HIV infection between June and December 1996 (T Meyers, unpublished data).

2.7 Other definitions

Pneumonia

This term includes all cases of lower respiratory tract infection or inflammation, including bronchiolitis, lung abscess, empyema and paraffin pneumonitis but excludes tuberculosis, chronic lung disease or bronchopulmonary dysplasia.

Gastro-enteritis

This term includes acute and chronic gastro-enteritis, as well as chronic diarrhoea that may not be infectious.

Tuberculosis

Children were defined as having tuberculosis if this was recorded as one of their diagnoses on the discharge summary sheet. Many of these children would have been diagnosed on clinical grounds alone, and without laboratory or histological evidence of tuberculous disease.

Immunisation-preventable diseases

This includes diphtheria, pertussis, tetanus, poliomyelitis and measles. It excludes tuberculosis due to the poor efficacy of BCG vaccine in Africa[41] and Haemophilus Influenza type B as this is not part of routine immunisation schedule in South Africa at present.

Malnutrition

Children were classified as malnourished (according to Wellcome criteria)[45] if the discharge summary categorised them as having marasmus, kwashiorkor, marasmic-kwashiorkor or being underweight.

Readmission

Data on readmission were obtained by searching through the computerised dataset for repeated admissions of the same child, as identified by hospital number.

3. RESULTS

3.1 General characteristics

In all, 22 633 admissions involving 19 918 children were recorded during the study period. The annual number of admissions increased by 23.6% (from 3 800 to 4 694) between 1992 and 1996. This increase was largely attributable to greater numbers of HIV infected children being admitted (Figure 1).

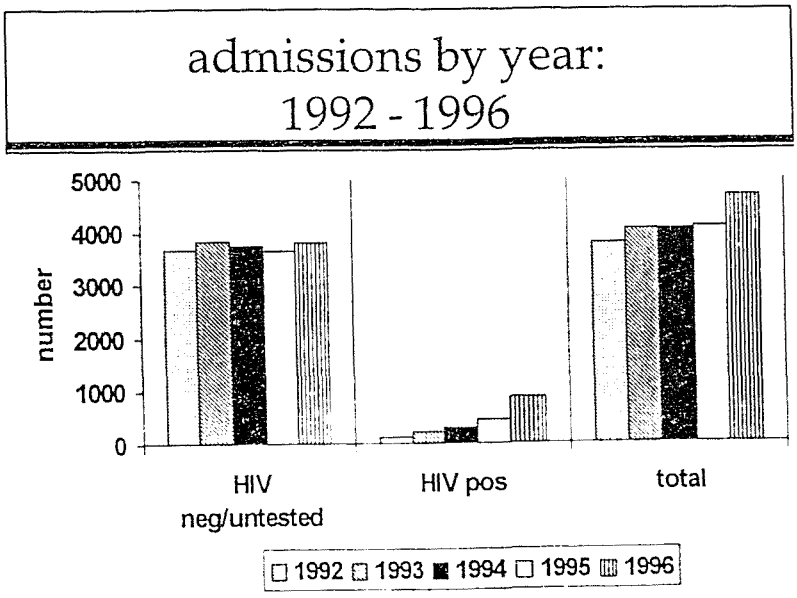

Figure 1: Number of admissions per year for HIV negative and untested, HIV positive children, and for all children

This should be placed within the context of total numbers of children required to remain overnight at Chris Hani Baragwanath Hospital in the "Sleepover" ward (largely pneumonia with minimal respiratory distress) and the Gastro-enteritis Unit (uncomplicated acute gastro-enteritis) (Figure 2).

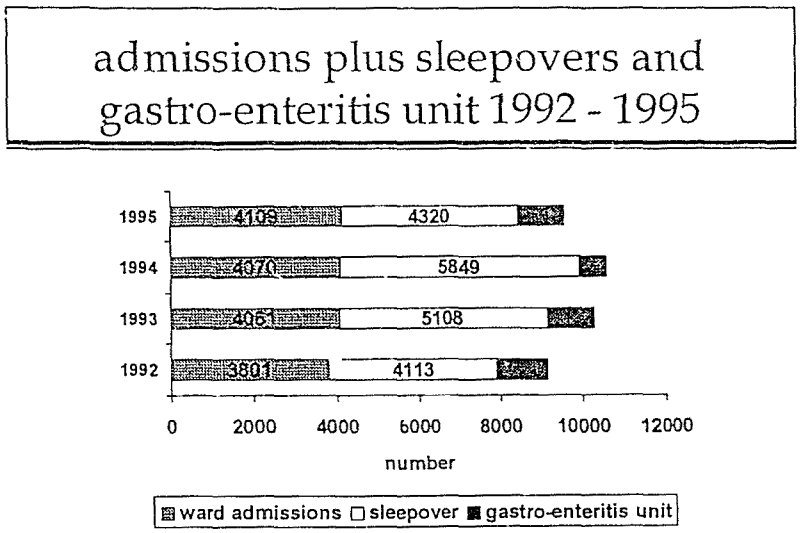

Figure 2: Number of ward admissions by year as well as those in "Sleepover" Ward and Gastro-enteritis Unit

3.1.1 Gender

Males accounted for 56% of admissions and females for 43.5%; gender was not recorded in 108 cases (0.5%).

3.1.2 Age distribution

The age distribution of admissions was skewed towards younger children. The majority of children were under the age of two years (66%) and almost half (49%) were under the age of one year. Children aged five years and under comprised 85% of admissions and the remaining 15% were aged six to twenty years. There were 175 admissions (0.8%) over twelve years, the official age cut-off for paediatric admissions.

3.1.3 Area of residence

Seventy-nine of admissions claimed to live in Soweto; 5.1% gave Johannesburg and its suburbs as their residential address and 6.6% gave the rest of the Gauteng area. Six percent admitted to living outside Gauteng Province. Soweto was cited as the area of residence less frequently in the early study years, 74% of admissions in 1992 and 1993 as compared with 86.8% and 84.8% in 1996 and 1997 respectively (χ^2 trend 315;$p<0.001$).

3.2 HIV infection

The proportion of children infected with HIV rose almost seven-fold over the study period (from 2.9% of admissions in 1992 to 20% in 1997), using the computerised dataset. The proportion of admissions recorded on the discharge summary sheet (computerised dataset) as being infected with HIV, the proportion who tested positive

through the SAIMR laboratory as well as the "best estimate" HIV using a combination of the two data sources is shown in Table I.

TABLE I: Comparison of annual HIV positive results by computerised data and SAIMR laboratory data, and the "best HIV estimate"

Admission year	Computer data HIV: % of admissions +	SAIMR HIV: % of admissions +•	"Best HIV estimate": % of admissions +	Number of children HIV + ("best estimate")
1992	2.9	2.8	3.2	120
1993	5.6	5.2	5.6	228
1994	7.5	7.1	7.5	304
1995	10.2	10.4	10.9	449
1996	18.2	13.2	18.5	870

•Note: HIV results from the SAIMR laboratory were available only until the end of September 1996.

The two data sources correlated well, apart from 1996, when the data from SAIMR was incomplete. The best estimate was sometimes higher than either estimate alone as the two data sources contributed complementary information on occasions, for example a child not recorded as HIV positive on the discharge summary may have been found to have a positive test at the laboratory

Approximately 1% of children later identified as HIV positive were not identified as such during their initial hospital stay. Thus these children were initially 'missed' as HIV infected children and required a repeat admission before their correct HIV status was established. For the purpose of the analysis, these children were allocated a positive

HIV status retrospectively once a later admission identified them as positive. The proportion not identified during their hospital stay increased steadily from 0.2% in 1992 to 1.8% in 1996, that is from fewer than one child in 1992 to 15 children in 1996

Over the study years, 7604 children, or 38.2% of all children were tested. The proportion of children who tested positive, negative and all who were tested is shown in Figure 3. Some children were tested in later study years but the figure records their HIV status on their first admission

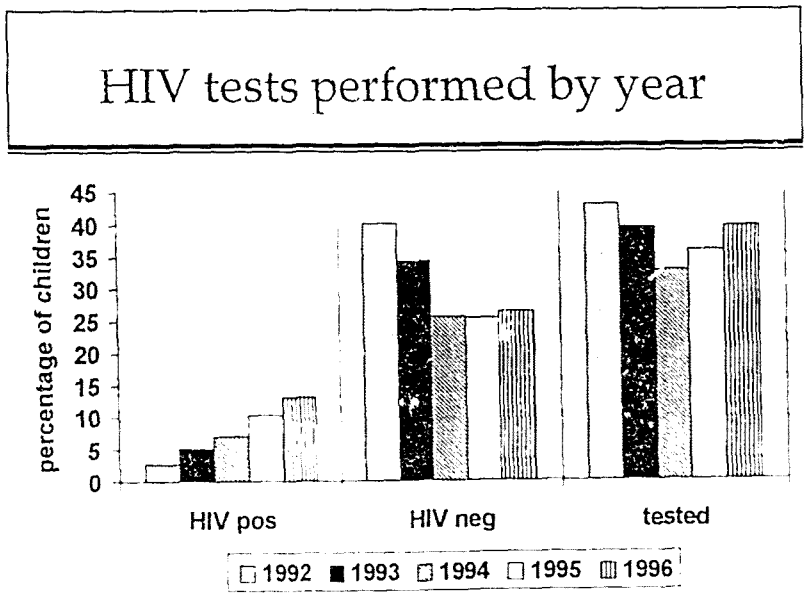

Figure 3: The percentage of children who tested HIV positive, tested HIV negative and who had a test for HIV by study year. Note: HIV results for 1996 available to September only

The age distribution for HIV positive and negative or untested children is shown in Figure 4 Mean age was 2.3 years for negative and untested children, and 0 6 years for infected children (F 524,p<0.001). For HIV negative children, 55% were less than 1 year of age and 74% under the age of 2 years The oldest patient was 20 years of age For HIV positive children, 67% were under 1 year of age and there were no cases recorded over the age of 10 years

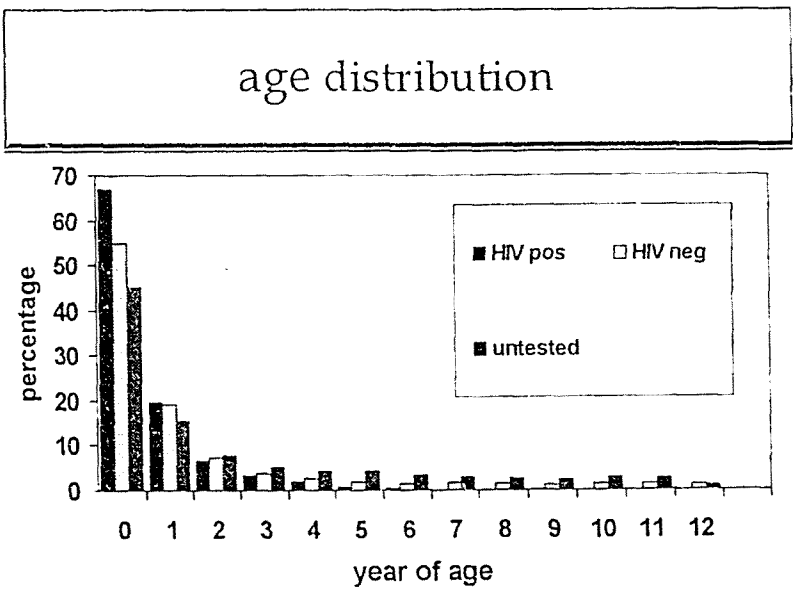

Figure 4: The percentage of children in each age category for HIV positive, HIV negative and untested children

HIV infected children were more likely to give Soweto as their residential address (83.2%) as compared with negative and untested children. Over the whole study period, 10.9% of children claiming to be from Soweto were infected with HIV, 8 3% from outside of Soweto were infected (χ^2 27,p<0 001)

3.3 Admission diagnoses

3.3.1 Pneumonia

For all children, pneumonia was the most common admission diagnosis and comprised 36.9% of admissions over the study period. This remained consistent over the years. The proportion of HIV positive children admitted with pneumonia was greater than the proportion of negative and untested children, 57.9% versus 34.3% children (χ^2 483;p<0.001) (Figure 5).

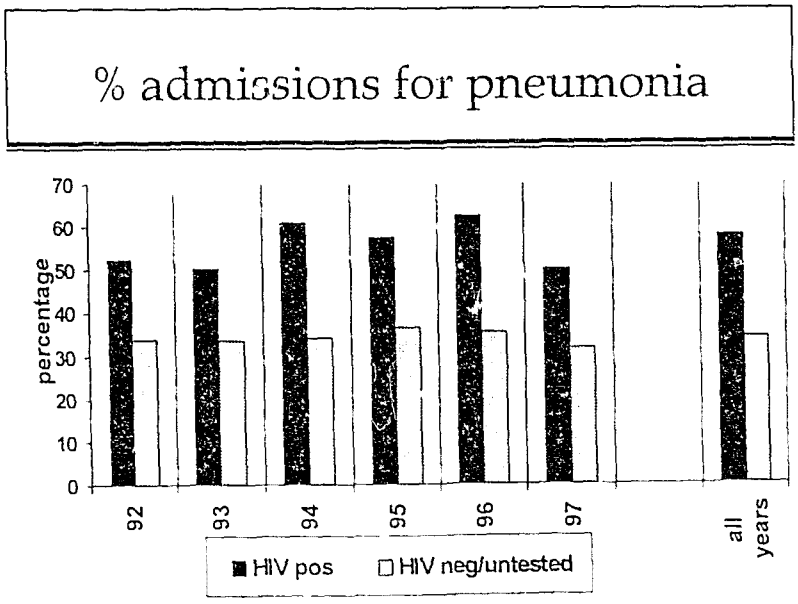

Figure 5: The percentage of admissions who had pneumonia by study year and for all years combined, for HIV positive, and HIV negative and untested admissions

Over the years, the absolute number of admissions for pneumonia rose steadily from 791 in 1992 to 1013 in 1996, attributable to pneumonia admissions in HIV positive children (Figure 6). Almost 29% of admissions for pneumonia were HIV positive in 1996, though in that year only 18.5% of admissions from all causes were known to be infected with HIV

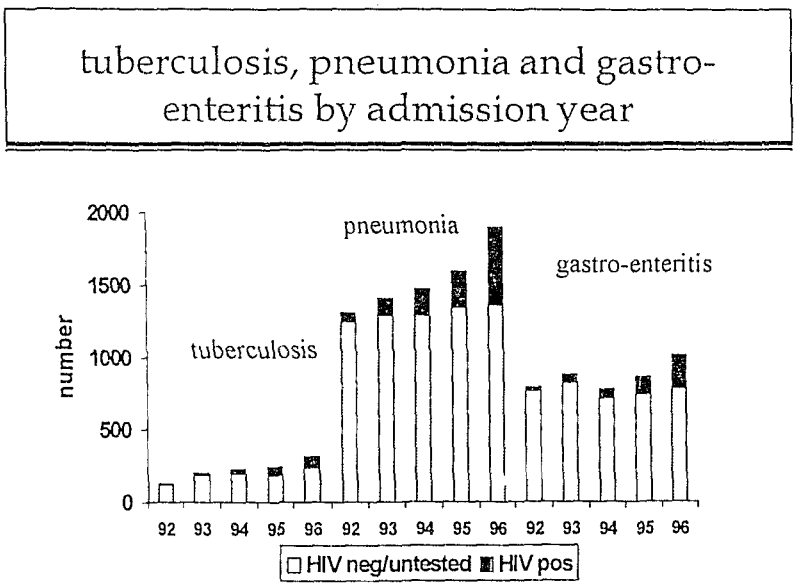

Figure 6: The absolute number of admissions who had tuberculosis, pneumonia and gastro-enteritis by study year for HIV negative and untested, and HIV positive admissions

The number of cases admitted for pneumonia in each year of age is shown in Figure 7 The frequency declines steadily with age and children under the age of one year comprise the majority of pneumonia admissions

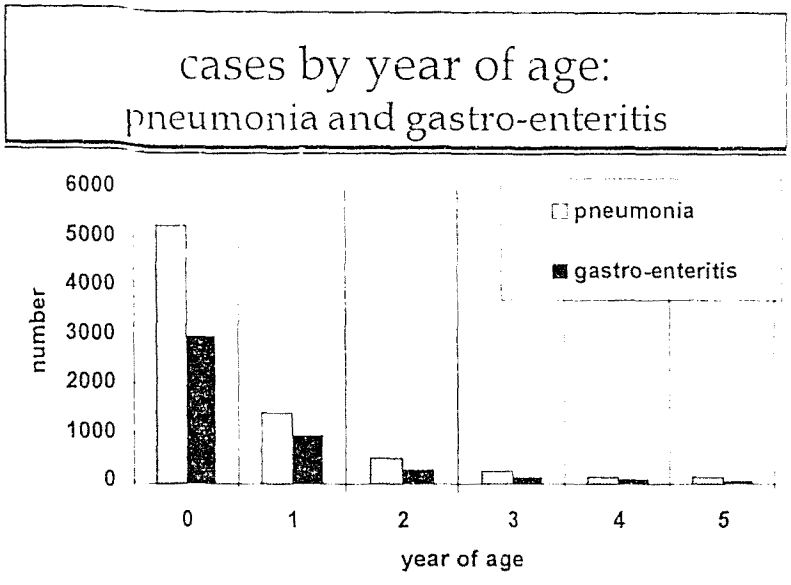

Figure 7: The number of admissions by year of age for pneumonia and gastro-enteritis

3.3.2 Gastro-enteritis

Admission for gastro-enteritis, which includes acute complicated gastro-enteritis and chronic diarrhoea, constituted 21 6% of admissions overall, with HIV positive children having a slightly higher risk, 29 4% versus 20 7% in negative and untested children (χ^2 90;p<0 001) (Figure 8)

Absolute numbers with gastro-enteritis also increased over the five year period, but not as strikingly as for pneumonia (Figure 6). In 1996, 24% of admissions for gastro-enteritis were HIV infected

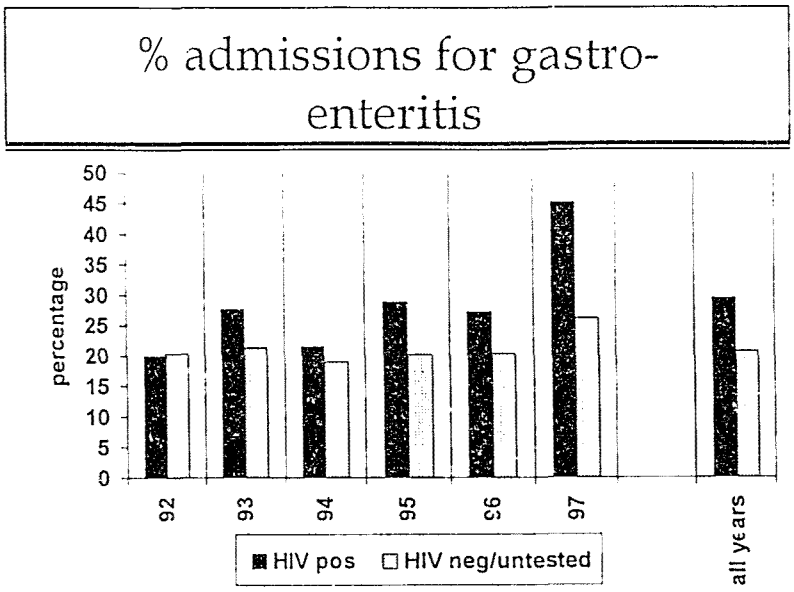

Figure 8: The percentage of admissions who had gastro-enteritis by study year and for all years combined, for HIV positive, and HIV negative and untested admissions

The frequency distribution for gastro-enteritis admissions by year of age is shown in Figure 7. As with pneumonia, there is a steady decline with age and children under the age of one year comprise the majority of gastro-enteritis admissions.

3.3.3 Tuberculosis

Proportions of children admitted with tuberculosis increased over the study years from 3.24% in 1992 to 8.26% in 1997. Increases were sustained over time in HIV negative and untested children; in HIV positive children there was a dip in 1996 (Figure 9). Eleven percent of HIV positive children were diagnosed as having tuberculosis, as compared with 5% of negative and untested children (χ^2 147, $p<0.001$). In 1996, HIV positive children accounted for 26% of all cases of tuberculosis. Absolute numbers with tuberculosis have increased steadily over time (Figure 6).

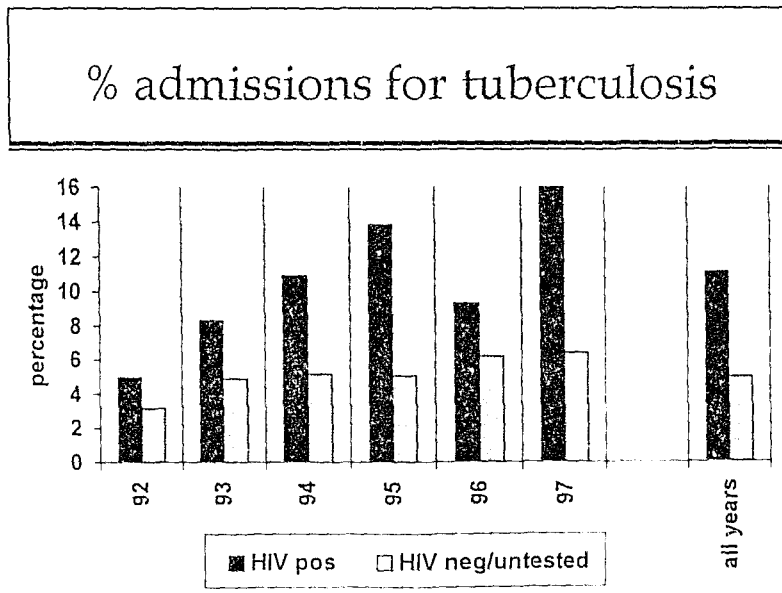

Figure 9: The percentage of admissions who had tuberculosis by study year and for all years combined, for HIV positive, and HIV negative and untested admissions

3.3.4 Pneumonia and gastro-enteritis

Four percent of admissions were given a combined diagnosis of both pneumonia and gastro-enteritis HIV positive children were far more likely to have this combined diagnosis, which comprised 9.7% of their admission diagnoses, compared with 3.7% of HIV negative and untested children (χ^2 192;p<0.001). 7.6% of HIV infected admissions with this combination died during their hospital stay whilst 4.5% of HIV negative and uninfected admissions with this combination died (χ^2 67;p<0.001;OR 6.6;95% CI 3.9-10.9) All the deaths were in children under the age of 4 years

3.4 Seasonal variation

Over all the study years, there was a marked seasonal variation, with March being the busiest month, and December the quietest (Figure 10).

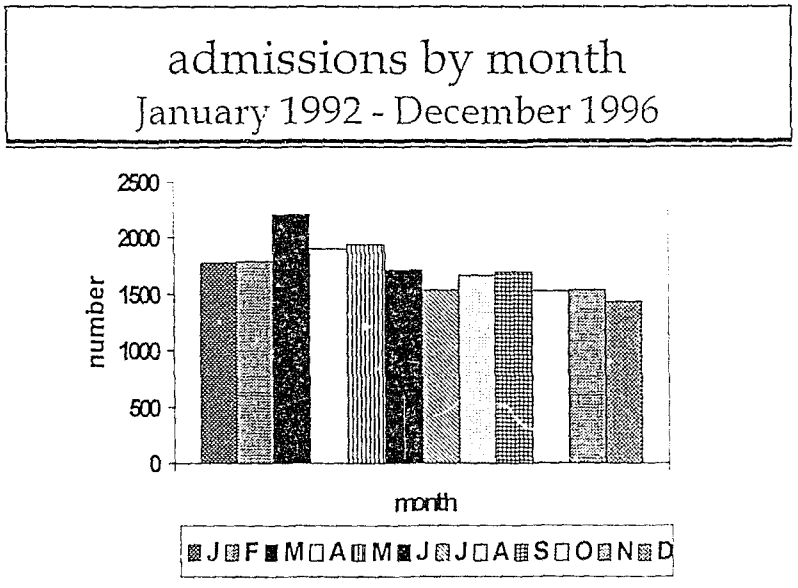

Figure 10: The number of admissions by month of the year for study years January to December 1992 to 1996

Both pneumonia and gastro-enteritis contributed to the March peak, whilst pneumonia is responsible for the bulk of admissions over the winter months (June to September) (Figure 11)

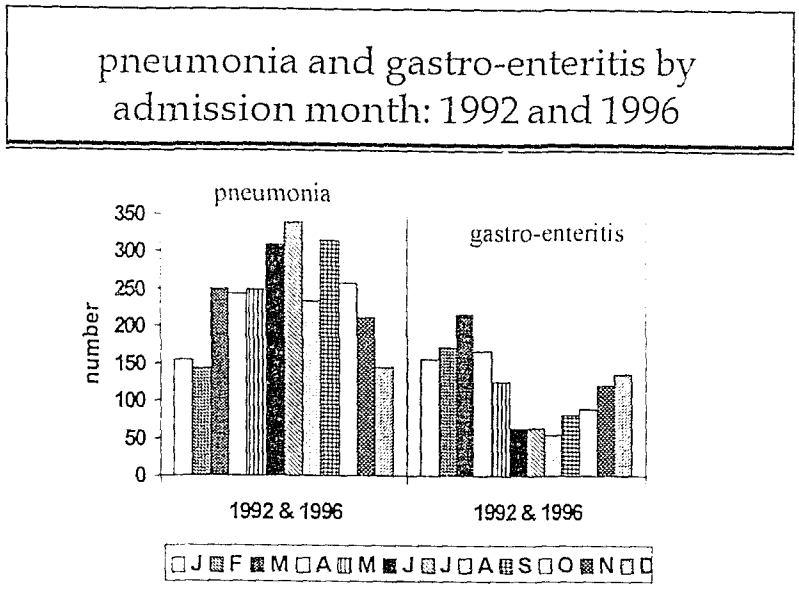

Figure 11: The number of admissions by month of the year for pneumonia and gastro-enteritis for the years 1992 and 1996

3.5 Nutritional status

Almost one quarter of all children were classified as malnourished on the discharge summary data using the Wellcome classification system[45]. Admissions from outside Soweto had higher rates of malnutrition, 33% versus 22.7% for Soweto children (χ^2 216;p<0.001).

Forty-five percent of HIV positive children were malnourished as compared with 22.2% of negative and untested children (χ^2 583,p<0.001,OR 2.8 95% CI 2.6-3.1) The proportion with malnutrition declined in the negative and untested group, from 26.6% in 1992 to 19-20% in the later study years (χ^2 trend 216,p<0.001) (Figure 12)

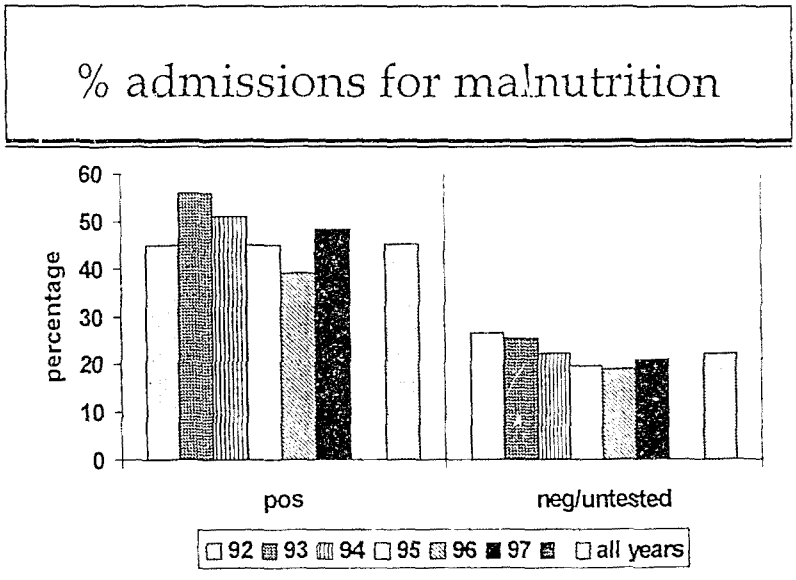

Figure 12: The percentage of admissions with malnutrition by study year and for all years combined for HIV positive, and HIV negative and untested admissions

The proportion of well-nourished children and category of malnutrition in each group is shown in Figure 13. Untested children had the highest proportion of well-nourished children. HIV infected children were more likely to be underweight (19.1%) and marasmic (13.9%) whereas HIV negative children tended to be underweight (15.8%) or have kwashiorkor (10.6%)

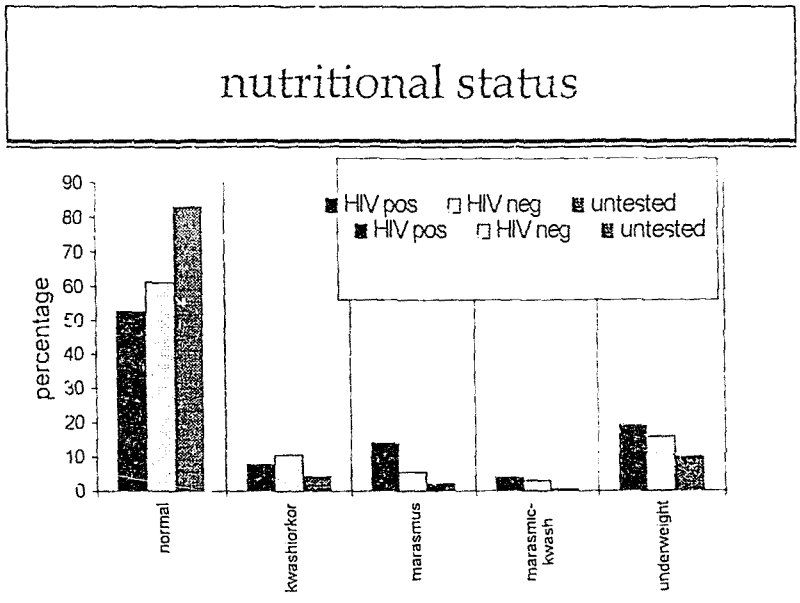

Figure 13: The percentage of admissions with normal nutritional status and the type of malnutrition for HIV positive, and HIV negative and untested admissions

3.6 Admission to the Intensive Care Unit

Admissions to the Intensive Care Unit (ICU) declined substantially over the study years, from 3.7% of admissions in 1992 to 1.2% in 1997 (χ^2 trend 43;$p<0.001$) (Figure 14). Only 23 children of the total 509 ICU admissions were infected with HIV. This reflects Chris Hani Baragwanath ICU policy, which has excluded children known to be infected with HIV from admission to ICU.

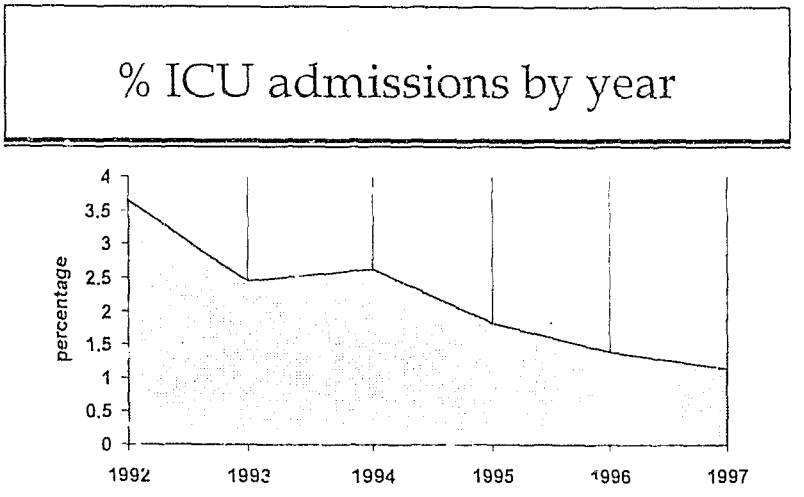

Figure 14: The percentage of admissions admitted to the Intensive Care Unit (ICU) in each study year

3.7 In-hospital mortality

The proportion of all admissions who died during their hospital stay increased by 42% over the study period, from 4.3% in 1992 to 6.1% in 1997 (Figure 15). This is due to the higher overall mortality in HIV infected children (13.2% versus 5.1% in uninfected and 3.1% in untested children) ($p<0.001$) and increasing proportions of infected children. In HIV negative children, mortality declined over time (χ^2 trend 3.3; $p=0.06$), whilst mortality in infected children showed no particular trend.

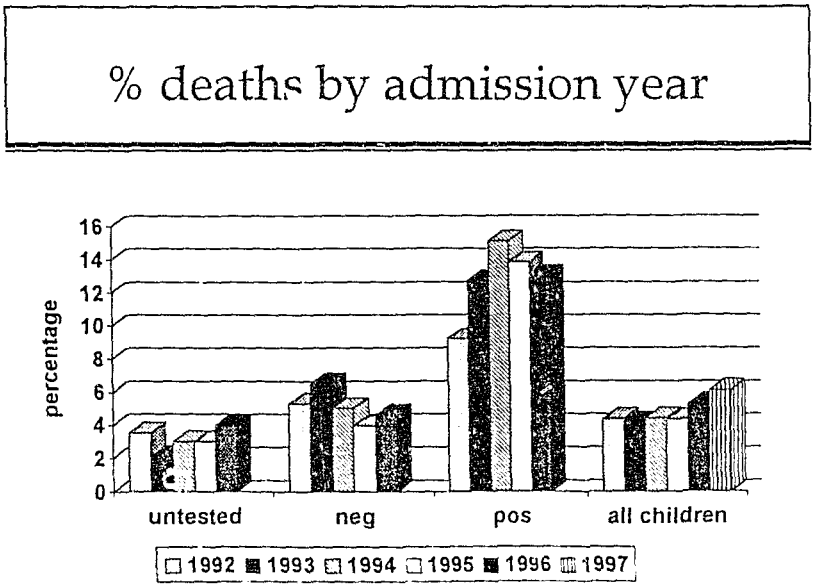

Figure 15: The percentage of children who died during hospitalisation in each study year for HIV untested, HIV negative, HIV positive children and all children combined

Death rates were lower for Soweto as compared with non-Soweto children (3.5% and 4.5% respectively) (χ^2 8.7;p=0.003;OR 0.77:95% CI 0.65-0.92).

3.7.1 Cause of death

During the study period, 1 051 children died. Of these, 324 (30.8%) were HIV infected over all study years. However the proportion of all children who died who were HIV positive increased strikingly from 6.7% in 1992 to 54.3% in 1997 (p<0.001). The most common causes of death in all children were pneumonia (24.6%), septicaemia (12,2%), gastro-enteritis (9.5%), nutritional causes (6.1%) and meningitis (4.9%). In the HIV negative and untested group, the five main causes were the same, followed closely be congenital abnormalities. In the HIV infected group, pneumonia assumed a greater proportion (52.8%), followed by gastro-enteritis (12%) and septicaemia (10.8%). "Other causes" made up the remaining 47.6% in the negative and untested group and 19.4% in the HIV infected group; these included viral hepatitis, chromosomal anomalies, complications of cerebral palsy, renal failure, tuberculosis and chronic cardiac or lung disease. In HIV negative and untested children, infectious and nutritional causes of death declined in absolute numbers between 1992 and 1996 (from 31 to 20, and 11 to 2 respectively), but these trends were not significant at the 5% level (p=0.4; p=0.3).

3.7.2 Age-specific in-hospital mortality

Infancy is the period of greatest risk of death in all children, 16.9% in HIV infected and 4.7% in HIV negative and untested children. For all children the risk of death in under

one year-olds has increased to approximately 6% as a result of the higher mortality in HIV infected infants. Mortality in children between one and six years old declined with age in HIV negative and untested children to 1.8% in five year-olds (P<0.001), whilst HIV positive children retained a relatively high risk of death throughout this age range (6.1 to 10.8%) (Figure 16). Of all deaths in under one year-olds, 36.3% were infected with HIV, this proportion declined with increasing age to 13% of deaths in five year-olds having HIV infection.

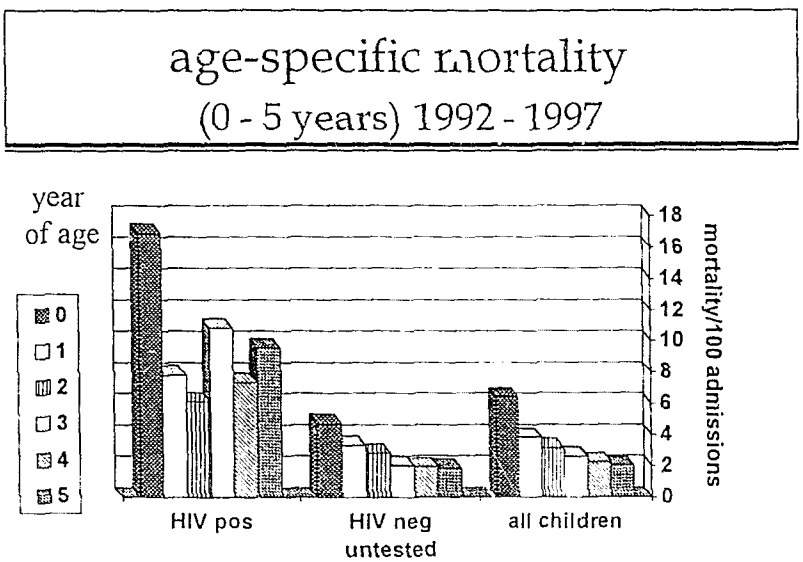

Figure 16: The number of children who died per 100 admissions for each year of age in HIV positive, HIV negative and all children

3.7.3 Case fatality rates

Case fatality rates for pneumonia were 2 to 6 times higher for HIV positive children (19.9%) as compared with negative and untested children (3.7%) ($p<0.001$) (Figure 17). In the negative and untested group there was a decline in case fatality rates between 1992 and 1997 that did not reach statistical significance, from 4.3% to 3.5% (χ^2 trend 2.46;$p=0.12$).

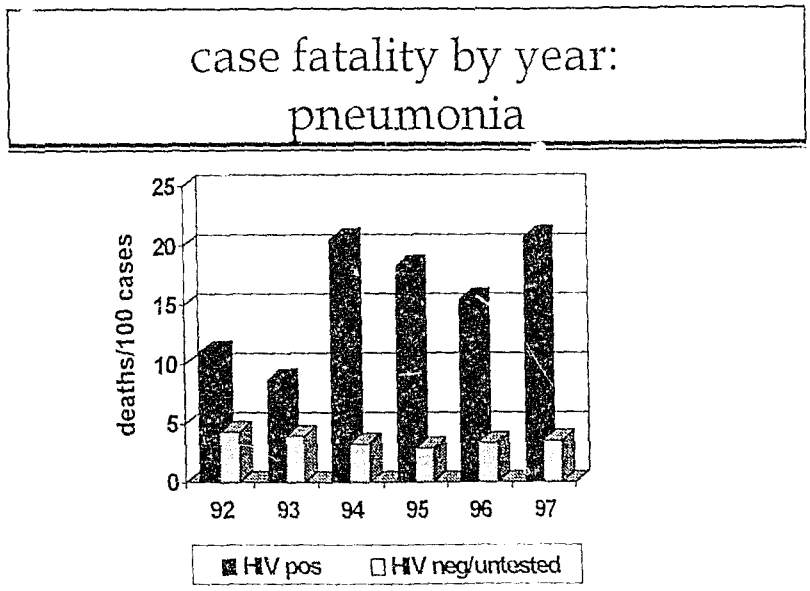

Figure 17: The case fatality rates for pneumonia in each study year for HIV positive, and HIV negative and untested children

Gastro-enteritis cases fatality rates increased from 3.5% in 1992 to over 4.5% in the later study years (χ^2 trend 5.01,p=0.025). Mortality in HIV positive children with gastro-enteritis was considerably higher (13.7%) than in those who were not tested or HIV negative (2.9%) (p<0.001) (Figure 18). There were no significant trends over time in either group (χ^2 trend 0.26,p=0.6)

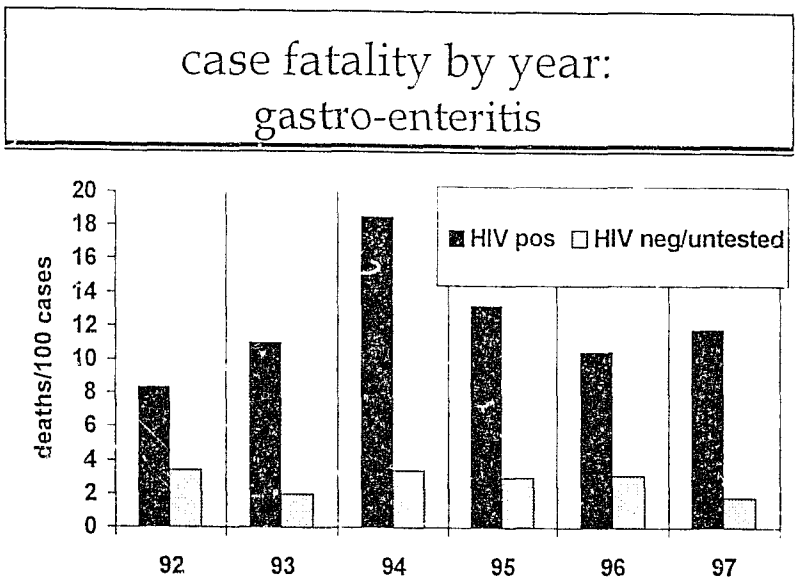

Figure 18: The case fatality rates for gastro-enteritis in each study year for HIV positive, and HIV negative and untested children

Children under 5 years of age had the highest case fatality for both pneumonia and gastro-enteritis. Case fatality declined with age for both pneumonia (χ^2 trend 26;p<0.001) and gastro-enteritis (χ^2 trend 11.3;p=0.001) (Figure 19). Peak case fatality rates were in under one year-olds, at 6.9% for pneumonia and 5% for gastro-enteritis. Pneumonia had higher case fatality rates than gastro-enteritis in the first 3

years of life (p<0.001). For children with a dual diagnosis of pneumonia and gastro-enteritis case fatality rate was 5.5%

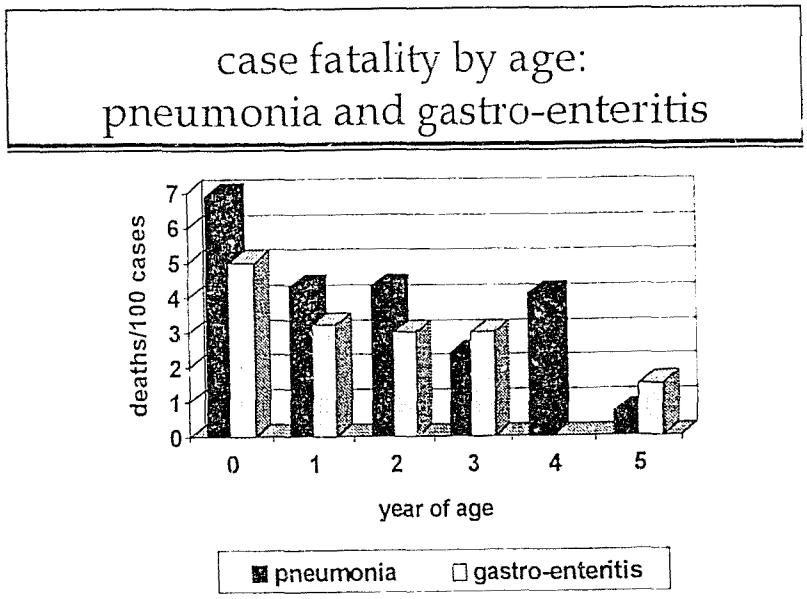

Figure 19: The case fatality rates for pneumonia and gastro-enteritis in each age category for all children

3.7.4 Mortality and nutritional status

Nutritional status was a good predictor of mortality, with well nourished children much less likely to die during their hospital stay (F 9.7;p<0.001). Almost five percent of all children died during their hospital admission. However, of those that had kwashiorkor, marasmus and marasmic-kwashiorkor, 6.4%, 7.1% and 10% respectively died. Four percent of well nourished children died and only 1.8% of children classified as obese on the discharge summary sheet died.

3.8 Length of hospital stay

Length of stay in hospital fell over the study period for all children ($p<0.001$). HIV infected children stayed substantially longer than untested and negative children in the early study years, but the difference remained of statistical significance throughout all years ($p<0.001$). On average, HIV infected children stayed 1.5 days longer than uninfected and untested children. The difference between the two groups became less marked over time ($p<0.001$, overall model fit $r=0.004$) (Figure 20).

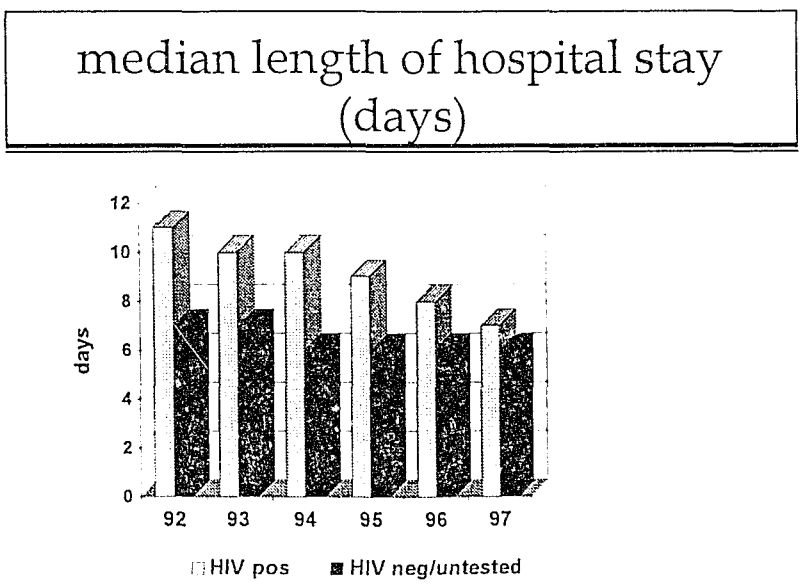

Figure 20: The median length of hospital stay in each study year for HIV positive, and HIV negative and untested admissions

The modal length of stay for children with pneumonia and those with gastro-enteritis was 4 days. Twenty eight percent of children with pneumonia and 32% of children with gastro-enteritis stayed for 4 days or less; approximately a quarter of children with either diagnosis stayed for 10 days or longer. Median length of stay in hospital was seven days for all conditions, for both children under two and over two years old.

3.9 Readmission

The majority of children (81.8%) had a single admission each year. HIV positive and HIV negative children were equally likely to have multiple admissions, but more likely than were untested children (Table II). There were no HIV positive children who had more than ten admissions per year.

TABLE II: Number of admissions for each child per year depending on HIV status

Number of admissions per child per year	% of all children	% of HIV positive children	% of HIV negative children	% of untested children
1	81.8	74.1	74.2	86.3
2	10.8	17.0	13.5	7.2
3 to 10	6.9	9.2	10.6	4.7
11 to 25	0.5	-	0.8	0.3

Figure 21 shows the frequency of multiple admissions per child per year.

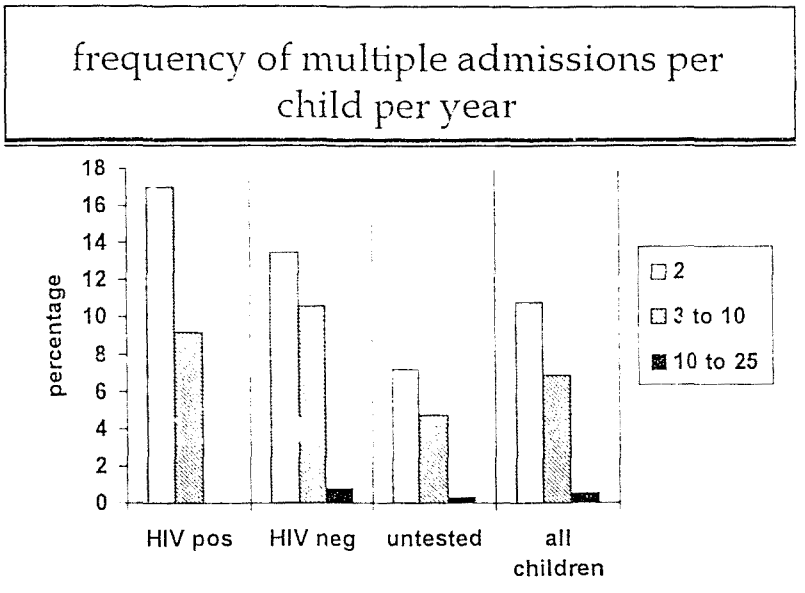

Figure 21: The frequency of multiple admissions per child averaged over all study years for HIV positive, HIV negative and untested children, and all children

3.10 Health trends in the HIV negative children

For children who were not infected with HIV, there was a decline in proportion of admissions over the study period for immunisation-preventable diseases as a group (diphtheria, pertussis, tetanus, poliomyelitis and measles), measles alone and rheumatic heart disease (acute and chronic). In contrast to these trends, asthma as a proportion of admissions increased from 3.2% in 1992 to 4.3% in 1996 and 4.1% in 1997 (p=0.04). Congenital anomalies of all types, including congenital heart disease and chromosomal disorders, remained relatively stable over the study period, as did paraffin ingestion and other forms of poisoning (Table III).

TABLE III: Selected diagnoses as a proportion (%) of admissions in HIV negative and untested children; figures for 1992 and 1997 only shown.

Diagnosis	1992	1997	p value for trend 1992 to 1997
Measles	2.3	0.5	0.016
Immunisation-preventable diseases	2.6	1.1	0.087
Rheumatic Heart Disease	1.7	0.6	<0.001
Asthma	3.2	4.1	0.04
Congenital abnormalities	3.5	3.2	0.24
Paraffin ingestion	0.8	0.7	0.72
Other forms of poisoning	2.1	2.4	0.79

HIV infected children were far less likely to be admitted for immunisation-preventable diseases (1.0% of admissions) ($p<0.001$), asthma (0.04% of admissions) ($p<0.001$), congenital anomalies (0.8%) ($p<0.001$), paraffin ingestion (0.04%) ($p<0.001$), and other forms of poisoning (0.3%) ($p=0.001$) as compared with HIV negative and untested children.

3.11 Validation of data

Ward statistics are collected by the registrars on intake as the patient is admitted to the ward and are likely to be more accurate than discharge statistics. They exclude those Haematology-Oncology patients who are admitted directly to that unit, whereas the computerised discharge data include all discharge summaries completed and reaching

the departmental clerk, including those from the Haematology-Oncology Unit. In order to compare the two sources of aggregate data, the Haematology-Oncology patients were excluded from the discharge data and then the sources were compared year by year until the end of 1996. This would under-estimate the accuracy of the computerised dataset as some patients are admitted to the Haematology-Oncology Unit via the wards and would thus be included in the ward admission statistics but not in the computerised dataset (as it is only possible to ascertain ward or unit status on discharge). The comparison is shown in Table IV. Over all the study years, at least 85.1% of admissions are captured by the computerised dataset.

TABLE IV: Comparison of admission statistics on computerised database and manually collected ward statistics

Admission year	Total admissions (computerised data)	Admissions excluding Haem-Onc (computerised data)	Ward admission statistics	% of ward admissions captured by computerised data (excluding Haem-Onc)
1992	3 801	3 713	4 404	84.3
1993	4 061	3 980	4 464	89.2
1994	4 070	3 916	4 670	83.9
1995	4 109	3 956	4 838	81.8
1996	4 698	4 591	5 319	86.3
over all years	20 739	20 156	23 695	85.1

4. DISCUSSION

4.1 Paediatric HIV infection and its effect on the profile of hospital admissions

Total paediatric medical admissions to Chris Hani Baragwanath Hospital have increased by over twenty percent in the five year study period. This is entirely attributable to the increasing numbers of HIV infected admissions. In contrast to this, the number of admissions in non-HIV infected children has remained stable over this period. As a direct result of the increased numbers of HIV infected admissions, there has been a shift in the age distribution towards younger children, increased admissions for pneumonia, gastro-enteritis, malnutrition and tuberculosis, greater readmission rates and higher in-hospital mortality rates. At the same time, there has been progressive shortening of the median length of stay during the study period and this may reflect the need for earlier discharge to make way for the higher patient load

The prevalence of HIV infection among hospitalised children in this study has increased almost seven-fold, from just under 3% in 1992 to 20% in 1997. These figures represent the lowest HIV seroprevalence in the children studied as they were tested only for clinical indications and were not routinely screened. The increase in HIV seroprevalence in hospitalised children reflects the increase in HIV infection among women of child-bearing age that has been documented throughout the country[22], and the consequent transmission to some of their babies. The seroprevalence rates found in this study lag behind the 28% seropositivity found at King Edward VIII

Hospital in 1995, where antenatal seroprevalence was at least 20% in 1996[22] Considering that we are thought to be in the rapidly rising phase of the HIV epidemic among adults, it is likely that we will see further increases in HIV seroprevalence amongst hospitalised children in the years to come.

The shift in the age distribution towards younger children has major staffing implications in that younger children require more intensive nursing care. By 1997, as many as two-thirds of HIV infected admissions were under the age of one year. This is not surprising and is explained by the fact that many children infected with HIV are at particularly high risk of infections during the first year of life[16]. Children who present with HIV disease early, the rapid progressors, often die from Pneumocystis carinii pneumonia or other infections in the first year of life. Those that progress more slowly present later in childhood and suffer from repeated infections until they become severely immunocompromised and ultimately die[17]. The age distribution reflects that few hospitalised children infected with HIV survive beyond 10 years of age. HIV infected children at Chris Hani Baragwanath Hospital, and most other parts of South Africa, are not offered antiretroviral agents and therefore the natural history of HIV disease in children is unaltered by these agents.

Other studies have shown that HIV infected children are at higher risk of pneumonia, gastro-enteritis, malnutrition, tuberculosis and multiple diagnoses[4 5 27]. Assuming that 18% of antenatal clinic attenders at Chris Hani Baragwanath Hospital are infected with HIV and that mother-to-child-transmission rates are 33%, it would be expected that

about 6% of the paediatric population under one year of age would be HIV infected. In this study, in 1996, 28.6% of admissions for pneumonia, 26% of admissions for tuberculosis and 24% of admissions for gastro-enteritis were HIV positive. This illustrates the 4 to 5-fold increased risk of admission to hospital for these diagnoses in HIV infected children. As a result of this, pneumonia admissions have increased by as much as 28% over the five years, and this is almost entirely attributable to HIV infected pneumonia admissions. In striking contrast, the incidence of pneumonia and gastro-enteritis has remained stable over time in HIV negative and untested children.

In line with trends in adults and children in many countries[26 29 32 33], admissions due to tuberculosis have more than doubled during the study period in all children, although the increase is more striking in the HIV infected group. This may be due to real increases in the prevalence of tuberculosis in the adult population, the infecting source of children, or may be as a result of heightened awareness of tuberculosis as a possible diagnosis and more children receiving a presumptive diagnosis than previously. Tuberculosis is difficult to diagnose in the childhood population as symptoms are non-specific and cannot be distinguished from disease caused by other agents, and appropriate specimens are difficult to obtain[18]. Therefore, awareness on the part of doctors of increased risk of tuberculosis in the community and in individuals infected with HIV may well result in a tendency to err on the side of the diagnosis of tuberculous infection and to commence the child on treatment. Since tuberculin skin tests, sputum or histology results are not recorded in the computerised dataset, it is not possible to establish the extent to which a definitive diagnosis was made in each child.

Almost half of all HIV infected children in this study are malnourished. This represents a higher proportion of malnutrition amongst HIV infected children than that seen in other studies, where 17% to 24% were malnourished[4,27,41] and may reflect that children with more advanced disease are referred to Chris Hani Baragwanath Hospital. HIV infected children have demonstrated less consistent a decline in malnutrition rates over the study period compared with HIV negative and untested children, perhaps because their nutritional status is less affected by improved socio-economic circumstances. Maintaining good nutritional status in HIV infected children is a recognised problem and requires invasive management, such as the insertion of gastrostomy feeding tubes, even in developed countries[19,30]. At Chris Hani Baragwanath Hospital, HIV infected children are not offered such procedures due to the cost implications and therefore their rates of malnutrition would be expected to be higher. Their predisposition to marasmus rather than kwashiorkor correlates with the findings of other studies[29] (T Meyers, unpublished data).

Other studies have shown that children with HIV infection are more likely to require multiple admissions[27,29,30] than HIV negative and untested children. One quarter of HIV positive children in this study were admitted more frequently than once per year, compared to thirteen percent in untested children. HIV infected children also stay longer in hospital (by one and a half days) compared with HIV negative and untested children. Considering that HIV infection predisposes children to repeated infections that are frequently difficult to treat, these admission findings are to be expected.

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4.2 HIV infection and its effect on the health service

The substantial increases in admission numbers and the longer hospital stay of HIV infected children have major implications for the health service. Bed occupancy was over 100% for a substantially greater proportion of the year in 1997 as compared with 1994 (J Pettifor, personal communication). The numbers of doctors and nurses has not been increased during this time period in order to cope with the additional load and this implies that medical staff:patient ratios have fallen and staff work-load increased. There has been considerable dissatisfaction expressed amongst nursing staff concerning work-load in recent years (J Pettifor, personal communication).

One might expect that the higher bed occupancy, reduced staff:patient ratios and increased work-load would have some impact on quality of care for hospitalised children. This data have shown no discernible impact on HIV negative and untested children in that mortality rates, ICU admission rates and readmission rates (UK Kala, unpublished data) have not gone up. However, more subtle aspects of quality of care are difficult to measure and are impossible to ascertain from this data. The pressure on beds may induce doctors to discharge patients earlier than they otherwise would have done and this may impact on time available for rehabilitation, patient education and counselling. Indeed the decline in length of stay over the study period may reflect that the pressure on beds is having an effect on the timing of discharge.

Treatment of HIV infected children with drugs that improve quality of life and prolong life is prohibitively expensive in South Africa. The impact of dealing with a terminal illness in vast numbers of young children to whom one can offer very little must take its toll on staff morale and work satisfaction.

The financial implications of the increases in HIV related admissions relate, not only to increased bed occupancy, longer hospital stay and the need for more staff, but also to the costs of medications offered to these children. Many children with HIV infection require more expensive and prolonged courses of medication, even if they are not offered antiretroviral agents. They are also more likely to require specialised intensive care facilities[30], although these are denied to them by an exclusion policy at Chris Hani Baragwanath Hospital. With regard to routine treatment, it is imperative that protocols that are affordable and that promote quality rather than quantity of life are implemented to prevent massive escalation in costs and unnecessary suffering.

4.3 HIV infection and its effect on in-hospital paediatric mortality

In this study HIV infection has been responsible for a 42% increase in overall in-hospital paediatric mortality and has reversed the trend towards lower rates of in-hospital mortality. Elsewhere in the world estimates of child mortality which were projected to decrease in the early 1980s due to improved immunisation and primary health care for children, have been revised upwards as a result of HIV infection[29]. In some countries where large numbers of women are HIV infected, the impact of HIV on child survival has been documented, although not in hospital-based studies. In

Zaire, infant mortality rate has increased by 15% and in Haiti a 12% increase in infant mortality rates has been directly attributed to HIV infections[54]. After evaluating data from ten central and east African countries, Preble estimated that HIV will cause between 250 000 and 500 000 deaths annually among children under five years by the year 2000. Whereas the United Nations estimate (without HIV/AIDS) for the under-five mortality rate in this region was 132/1000 by the year 2000, HIV will cause the under-five mortality rate to rise to between 159 and 189/1000, that is an increase of between 20% and 43%[51].

In this study the rise in in-hospital mortality was most striking in the under one year-olds. HIV infected children under the age of one year have a 17% chance of dying during their hospital stay, much higher than the 4.7% chance in HIV negative and untested children. This is probably due to the high case fatality rates for pneumonia and gastro-enteritis in those under the age of one year, especially if they have HIV infection. They are also at higher risk of more than one current illness, which increases their mortality risk. Many of the pneumonias in this age group are likely to be due to Pneumocystis carinii, a pneumonia that is largely preventable by early detection of HIV infection and prophylactic medication. Considering that over the whole study period, 36% of all deaths in those aged one year or less were HIV-related, this is the group that would gain most from HIV prevention and management strategies.

Younger children are at consistently higher risk of death[27, 35, 41]. Indeed, in this study the first year of life carries the highest mortality for all children, irrespective of HIV

status. However for HIV infected children, each age category above one year carries a relatively high chance of death, in contrast with negative and untested children, whose death rates decline substantially with age. This reflects the lethal nature of HIV infection in children, in whom no proven cure presently exists. The longer life expectancy seen in developed countries does not seem to occur in this population, even when outpatients are included (T Meyers, personal communication). This is probably because of the absence of antiretroviral agent usage, which is associated with increased survival time[52], the poor nutritional status of children and the high exposure to infectious agents in the community.

Those with the least risk of dying in this study are those children who have never been tested for HIV. Three percent of these untested children die during their hospital stay, as compared with 5% of HIV negative children and 13% of HIV positive children. This is to be expected since these are children who are likely to be well-nourished, who present with acute, uncomplicated illness, who recover quickly and who present no reason prompting the attending clinician to perform an HIV test.

Children who have been tested for HIV but who are negative are likely to be children with chronic respiratory, cardiac or gastrointestinal disease, failure to thrive or signs that could fit with an HIV diagnosis, such as hepatosplenomegaly or generalised lymphadenopathy. This group of children would be expected to have higher readmission rates and death rates than those with little indication to be tested for HIV. These probabilities are reflected in the data, with readmission rates in the HIV negative

children approximating those of the HIV infected children, and death rates being higher than in untested children.

HIV infected children in this study have almost three times the risk of dying during their hospital admission as compared with HIV negative and untested children. Although in-hospital mortality rates for HIV infected children have been found to higher in studies elsewhere in Africa (19 - 20%), infected children consistently have at least double the risk of dying during hospitalisation as compared with uninfected children[4 27]. The in-hospital mortality in HIV positive children seen in this study correlates closely with the other study performed at Chris Hani Baragwanath Hospital in 1996 (T Meyers, unpublished data), and with the in-hospital mortality documented in a Cape Town tertiary referral hospital[28]. Even in countries where HIV disease is managed with maximal interventions, infected children have a mean survival time of 9.4 years[53] and seldom survive beyond 15 years of age and thus would be expected to have high childhood mortality rates.

Malnutrition was a good predictor of death in this study. Whilst 4% of well-nourished children died, 10% of children with marasmic-kwashiorkor died. Malnutrition was the fourth most important cause of death at this hospital. Malnourished children are more likely to die than are well-nourished children[54]. The higher mortality amongst HIV infected children may in part be attributable to their poor nutritional status and one way of reducing early mortality may be to address nutrition aggressively, as is done in developed countries. However, in a country where background rates of malnutrition

are high, it may not be ethical to target HIV infected children for intensive nutrition interventions.

The impact of HIV disease on in-hospital paediatric mortality is alarming when one considers the proportions of hospitalised children dying due to HIV disease. In 1992, almost 7% of death were HIV related, whereas by 1997, HIV infected children accounted for *over half* of all ward deaths. At Chris Hani Baragwanath Hospital, 75% of all deaths have been HIV related in the early months of 1998 (UK Kala, personal communication). These are trends that are likely to continue well into the future.

4.4 The effect of area of residence

Although inaccuracies in the data on area of residence may dilute expected differences, there *were* differences between children claiming to live in Soweto and those from outside. One fifth of Soweto children were malnourished as compared with non-Soweto children, one third of whom were malnourished, reflecting the relative affluence of the Soweto community. In-hospital mortality rates were also lower for Soweto children. Apart from socio-economic factors, this may be because Soweto children have ready access to primary health care and hospital services and may present earlier than non-Soweto children. They are also more likely to be using Chris Hani Baragwanath Hospital as their local community hospital and therefore to be less ill, as opposed to children from outside Soweto, who are more likely to be referred patients and patients who are not satisfied with the treatment obtained elsewhere.

It is surprising that Soweto is cited as the a sidence less frequently in the early study years as there is no obvious reason for patients to be more inclined to give an incorrect address in the later years. This may reflect improved access to other hospitals in the region, such as Johannesburg Hospital, during the study period.

4.5 Health trends in the HIV negative children

In contrast to HIV infected children, the total number of admissions per year has remained stable over the study period for children who are not infected with HIV. Uninfected children have shown substantial declines in malnutrition rates, rates of vaccine-preventable diseases especially measles, and rheumatic heart disease, a finding consistent with other developing country studies[3]. Uninfected children have demonstrated slight declines in in-hospital mortality rates as well as case fatality rates for pneumonia. Together with the increase in asthma admissions and admissions for other chronic diseases, this may herald the beginning of a shift towards a more developed world profile of disease.

There has been a seventy percent reduction in admissions to the Intensive Care Unit in untested and HIV negative children over the study period. This has occurred without an increase in death rates, suggesting that it may reflect a reduced requirement for such facilities. The Intensive Care Unit has noted a decline in the requirement for paediatric beds as a result of severe and complicated measles infection (H Hon, personal communication). Although limited in their usefulness, these parameters may reflect that

fewer hospitalised children who are not infected with HIV are critically ill in 1997 compared with 1992.

The causes of death have changed during the study period, with declines in infectious and nutritional causes. This is a trend that has been seen in white children in South Africa since 1929[34]. The most frequent cause of death in this study was pneumonia, almost three times more frequent than gastro-enteritis. This also follows trends seen in white and 'coloured' children in whom pneumonia had overtaken gastro-enteritis as the main cause of death in 1985[8]. This is most likely to reflect improved sanitation and the effectiveness of rehydration therapy and diarrhoeal control programmes in urban areas such as Soweto. It is likely that HIV infected children respond less well than uninfected children to rehydration therapy and therefore the impact of these strategies may be limited in this group.

4.6 Limitations

4.6.1 Data accuracy

This validity of this study depends on the accuracy with which the information about each child's admission is entered onto the summary sheet and then entered into the computerised database. Breakdowns in the system of transfer of summaries to the departmental clerk and failure to enter data onto the computer will result in under-estimation of the number of children admitted to hospital. Compared to manually collected ward statistics, these data captured over 85% of hospital admissions.

Whilst it is likely that most discharge summaries are completed to some extent (as it is ward policy that the mother be given a copy on her child's discharge), the completeness of the information may vary considerably. Mortality data are likely to be most accurately recorded as a designated clerk reminds doctors to complete summaries together with death certificates in children who have died. Information that was central to the analysis, such as age, gender, dates of admission, discharge or death and diagnostic information were well recorded. Less well recorded were nutritional status and area of residence, but the sample in which these variables were well recorded are unlikely to differ systematically from the remainder of the sample population.

Inaccurate diagnostic information and coding errors may cause random misclassification. This is likely to be constant from year to year and are therefore unlikely to affect analyses of trends over time.

4.6.2 The use of routine data

Utilising routine data and a retrospective study design limit the degree of analysis that can be performed. Specific research questions, such as risk factors for death from pneumonia can only be addressed very crudely (e.g. HIV status or age) and detail that may be of interest, such as the infecting organism, was not available on this dataset.

Routine systems of data entry are likely to be slower than in studies where specific data entry clerks are employed. The time lag in getting this data on to the computer in the

Department of Paediatrics was about six months, making analysis possible only until the end of April 1997.

4.6.3 Generalisability

The computerised dataset applies only to those children who are admitted to the paediatric medical wards and the Haematology-Oncology Unit. There is very limited data available for children required to stay in "Sleepover" ward or Gastro-enteritis Unit and these children were excluded from the analysis. Since admission criteria to these units require children to be less ill and not clinically malnourished, they are likely to have lower mortality rates and rates of HIV infection. Were they to be included in the analysis, the rates of HIV infection in all hospitalised children would probably fall, as would mortality rates.

Chris Hani Baragwanath Hospital provides a tertiary level service to which children are referred from a wide range of secondary level hospitals in addition to the provision of primary and secondary level care for the Soweto population. It is likely that children who are chronically unwell, critically ill and who have HIV infection are referred, therefore boosting the numbers of such children. Comparing data with other hospitals in the region is not feasible for this reason and valid comparisons may be with other tertiary services only.

Considering that the patients come from a large geographical area, and accurate population denominators are not available, it is not possible to calculate prevalence or mortality rates on a population basis. Documenting these rates would require a clearly defined population with systems to ascertain these events in those not seeking health care at the hospital. Therefore the morbidity and mortality data established in this study cannot be generalised to the general population of Soweto or any other population.

4.6.4 Estimates of HIV infection rates

HIV infection rates are likely to be an underestimate of true rates of HIV infection in children for several reasons:

(i) In most study years the computerised dataset revealed slightly higher proportions of children infected with HIV compared with the SAIMR laboratory data. This was most likely due to poor matching of hospital numbers on the two datasets and suggests that many of the HIV tests performed were not picked up by the computer search for them on the SAIMR computers.

(ii) SAIMR data were made available only until the end of September 1996, which probably accounts for the large discrepancy between the datasets in 1996. The later study years were a time when HIV infection in children was rising rapidly and thus complete SAIMR data from October 1996 to the end of April 1997 may have contributed substantially to a more accurate HIV estimate.

(iii) The ward data may not contain the child's HIV status as part of the coded diagnosis, which will result in that child's HIV status being unrecorded.

(iv) Children were only tested if there were clinical signs suggestive of HIV infection. If all children were screened for HIV, a higher rate of HIV infection would be expected as some children may not have typical clinical features. The extent of this can be measured against the study in children admitted to Chris Hani Baragwanath in 1996 in which most children (those with informed consent) admitted to one of the paediatric medical wards were screened for HIV (T Meyers, unpublished data). In this study, 28% of children were found to be infected, a higher estimate (by about 8%) than that found using the computerised dataset in that year, and higher than the 5% difference found comparing children who were screened and those tested for clinical indications in Durban[28] Dr Meyers' study involved a six month period in one ward only and may by chance be higher than the general paediatric medical admission population. This is unlikely, however, as the wards rotate admission days

As was evident in the data, some children were only tested after several admissions to hospital, as it only then became evident that HIV infection may play a role. This would influence the HIV status allocated to children in the later study years, as they may be presenting for the first or second time only and therefore may not yet have been tested. The number of children in this group is likely to be small, however.

Since the SAIMR data did not capture some of the HIV tests that must have been performed in order for doctors to record the child as HIV positive on the discharge summary sheet, the final estimate relies largely on ward data. This data informs us that the child is HIV positive in the coded diagnosis, but does not inform as to whether the child *had* an HIV test which was negative, or was not tested at all. Therefore much of the analysis uses the "best HIV estimate", and simply distinguishes HIV positive admissions from HIV negative and untested admissions as a single group. Where HIV positive, negative and untested data are presented, SAIMR data has been used, which differed from ward data especially in the later study years.

4.6.5 Geographical data

The information on area of residence relies to a large extent on the information obtained by the admitting clerk. It is the medical staff's perceptions that the addresses given are frequently a relative's address in Soweto, and not the child's usual residential address, if the child lives outside of Soweto. Although this is unlikely to have changed significantly over the study period, the accuracy of the residential address given must be questioned. The suspected inaccuracy of geographical information and the small numbers claiming to live outside Soweto meant that analyses looking at differences between the Soweto and non-Soweto children may be subject to systematic error.

4.6.6 Health trends in the HIV negative children

Assessing health trends and disease severity in the non-HIV infected group is complex since the variables require careful interpretation. Case fatality rate and nutritional status may be the only feasible measures. Studies looking at disease severity usually involve collection of detailed physiologic parameters in a prospective fashion[55], data that are not available in this dataset. Length of hospital stay is difficult to interpret, as it is determined by many factors other than the severity of the child's disease. Similarly, admission to the Intensive Care Unit (to which HIV infected children are denied admission) may be more a reflection of the varying availability of ICU beds rather than the severity of disease. Despite these limitations, it is unlikely that there have been any systematic changes over the study period and therefore an analysis of the trends over time remains of value.

4.6.7 Cost data

Since the hospital has poorly developed systems for costing admissions and procedures performed on children, there has been no attempt to accurately cost the impact of HIV disease in this study.

4.7 Future Work

This study was performed in part to inform policy on services for hospitalised children and indeed has already been used for that purpose. Staff ratios can be calculated based

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This study was performed in part to inform policy on services for hospitalised children and indeed has already been used for that purpose. Staff ratios can be calculated based

on patient numbers and nurse allocation can be recommended on the basis of rising numbers of ill children. The data can also be used, in a future study, to stratify patients by level of care required, i.e. Level II or Level III and therefore to decide on the numbers of subspecialty posts that would be appropriate for hospitals like Chris Hani Baragwanath.

Presentation of this data to health policy-makers makes a striking case for attempting to reduce the costs and resources incurred by paediatric HIV disease. This may impact on decisions to introduce interventions to reduce mother to child transmission by a variety of methods, including the use of AZT during pregnancy

This study has demonstrated the usefulness, despite its limitations, of routine data collection. It is hoped that analysing and presenting this data to the clerical staff and doctors involved in this process will motivate them to continue and to improve in their completion and entry of discharge summaries.

Health information systems similar to that utilised here would be extremely useful in health planning and in monitoring health status if more broadly implemented and this suggestion is being considered Province-wide.

The discharge summary form could be simplified in order to make it more user-friendly, as could the coding booklet currently used by doctors. The researcher will be involved in this process.

5. CONCLUSIONS

This study has documented that in the paediatric medical wards at Chris Hani Baragwanath Hospital:

* admissions have increased by over 20% during the five year study period, and this is attributable to increasing numbers of HIV infected admissions
* the prevalence of HIV infection has increased from just under 3% in 1992 to over 20% in 1997. This has resulted in:
    - a shift in the age distribution towards younger children, increasing the requirements for nursing staff
    - increasing admissions for pneumonia, gastro-enteritis, malnutrition and tuberculosis
    - greater readmission rates
    - shortening of length of hospital stay, possibly to make way for the increasing numbers of patients requiring admission
    - an increase in in-hospital mortality rates by 42%
* children who are not infected with HIV have had:
    - stable admission rates
    - declines in malnutrition rates, rates of vaccine-preventable disease, and rheumatic heart disease
    - declines in in-hospital mortality rates and case fatality rates for pneumonia
    - declines in deaths for infectious and nutritional causes

• declines in admissions to the Intensive Care Unit

* routine data collection systems are extremely useful and should be maintained and improved

* there is a need to develop appropriate policies for the early identification and tr ment of HIV infected children

APPENDIX 1: The routine discharge summary sheet used for paediatric medical admissions at Chris Hani Baragwanath Hospital

DEPARTMENT OF PAEDIATRICS - BARAGWANATH HOSPITAL

BASIC DATA: (All dates dd mm yr)

DATE OF ADMISSION...../...../..... PUF.....

SURNAME..... FIRST NAME ..... UNIT NO.....

READMISSION: Y N SEX: M F DATE OF BIRTH...../...../.....

AGE: ....YRS..... .....MO RESIDENTIAL AREA CODE.....

FINANCIAL CATEGORY..... PRIMARY REFERRAL CODE.....

CLINICAL DATA:

NUTRITIONAL STATUS..... WT (KG)..... HT (CM).....

PRIMARY DIAGNOSIS:

..... CODE..... SYSTEM CODE.....

SECONDARY DIAGNOSES:

1)..... CODE.....SYSTEM CODE.....

2)..... CODE.....SYSTEM CODE.....

ORGANISMS CULTURED AND SITES:

OUTCOME DATA:

ADMITTED TO MAIN ICU: Y N

DIED: Y N *IF YES:* DATE OF DEATH...../...../.....

IF NO: DATE OF DISCHARGE OR TRANSFER:...../...../.....

IF TRANSFERRED STATE WHERE TO.....

COMPLETED BY (PRINT NAME)..... DATE...../...../.....

SIGNATURE: _____

SUMMARY: REFERRING DOCTOR.....

DISCHARGE WEIGHT..... MEASLES VACCINE: Y N

TTO MEDS:

FOLLOW UP DATE...../...../.....

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