OUTCOME OF PNEUMONIA IN CHILDREN ADMITTED AT KENYATTA NATIONAL HOSPITAL.

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DECLARATION

I declare that this dissertation is my original work and has not been published elsewhere or presented for a degree in any other university.

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DEDICATION.

TO MY MOTHER NJERI FOR BEING A MUM IN ALL SEASONS.

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TABLE OF CONTENTS **PAGE**

LIST OF ABBREVIATIONS

CI	Confidence Interval
CoNS	Coagulase Negative Staphylococci
CSF	Cerebral Spinal Fluid
GNEB	Gram Negative Enteric Bacilli
HIV	Human Immunodeficiency Virus
IMCI	Integrated Management of Childhood Illnesses
KEMRI	Kenya Medical Research Institute
KNH	Kenyatta National Hospital
LP	Lumbar Puncture.
OR	Odds Ratio.
PFC	Paediatric Filter Clinic
RTI	Respiratory Tract Infection
SPSS	Statistical Package for Social Sciences.
WHO	World Health Organisation

LIST OF FIGURES AND TABLE **PAGE**

ABSTRACT

Background:

Acute lower respiratory tract infections cause considerable morbidity and mortality in children under- 5 years of age especially in developing countries. This is unlike in developed countries where outcome of pneumonia has been shown to improve over time possibly due to improved treatment as well as preventive measures. Locally at Kenyatta National Hospital (KNH), mortality rate due to pneumonia has remained high in the last two decades.

This poor outcome has been attributed to some factors such as severity of pneumonia which tend to be of bacterial origin, malnutrition and HIV infection which are more prevalent in developing countries. The extent to which these factors influence pneumonia outcome at KNH is not known.

Objective:

To describe short term mortality outcome of children admitted with severe and very severe pneumonia at KNH as well as its association with HIV, weight for height Z scores, bacteremia, hypoxemia and clinical severity. Additionally describe initial antibiotic prescriptions for children admitted with severe or very severe pneumonia at KNH.

Outcome measure: Death within one week of admission.

Design:

Descriptive cross-sectional study

Setting: The study was carried out in Paediatric Filter Clinic (PFC) and general wards of Kenyatta National Hospital a national referral and teaching hospital.

Method:

Children aged between two and 59 months who were attended at PFC and evaluated for severe or very severe pneumonia as per WHO guidelines were consecutively recruited.

A physical examination, oxygen saturation, blood culture, and serology for HIV were performed on all study participants.

Lumbar puncture was performed on those who had features suggestive of meningitis. Information on antibiotic prescription both at PFC and wards was recorded on the day of admission. The study participants were then monitored in the wards within the week of admission to document the outcome. This information was obtained from the patients' files.

Data was entered into SPSS and analysed using the same.

RESULTS:

A total of 251 children were studied. Patients admitted with very severe pneumonia were 73 (29.1%). In total, 33 (13.1%) children died within the week of admission. Of the deaths, 63.6% occurred within 48 hrs of admission, whereas the average duration of hospital stay for the survivors was 5.2 days.

The factors that were associated with short term mortality in multivariate analysis were: HIV infection (OR 12.7 CI 4.9-33.0), inability to feed (OR 4.5 CI 1.8-11.4), and severe dehydration (OR 6.7 CI 2.3-19.3).

Inappropriate choice of initial antibiotics as well as inadequate doses was noted both at PFC and in the wards. For instance 67% of children admitted with severe pneumonia received inappropriate choice of initial antibiotics. In HIV infected children admitted

with pneumonia, 38.3% missed cotrimoxazole in the initial antibiotic prescription for treatment or prophylaxis against *Pneumocystis jiroveci* pneumonia.

CONCLUSION

The short term mortality rate of children admitted with pneumonia was 13.2%. Mortality was higher among those with the very severe form (72.7%). Early deaths (within 48 hours of admission) occurred in 64% of the children hence aggressive and timely interventions are needed in order to reduce mortality due to pneumonia.

The factors that were highly associated with short term mortality in multivariate analysis were: HIV infection (OR 12.7 CI 4.9-33.0), inability to feed (OR 4.5 CI 1.8-11.4), and severe dehydration (OR 6.7 CI 2.3-19.3). Adequate and effective supportive therapy in feeding and fluids administration might therefore reduce mortality due to pneumonia.

Inappropriate choice as well as inadequate doses of initial antibiotics was noted in children admitted with pneumonia both at PFC and in the wards

1.0 INTRODUCTION

1.1 Burden of Pneumonia

Acute respiratory tract infections (ARI) particularly pneumonia is one of the top five causes of infant and under five morbidity and mortality globally [1]. About 1.9 million Children aged less than five years died from ARI in year 2000 worldwide, 70% of them in Africa and southeast Asia[2]. It's estimated that currently 4 million of the 15 million annual deaths in under- 5's is due to pneumonia [2,3]

Remarkable progress has been made in development of antimicrobial therapy, effective vaccine and pneumonia management guidelines in the past 50 years. However pneumonia is currently the leading cause of death in children under five years of age in developing countries accounting for approximately 20% of childhood deaths. HIV/AIDS and overcrowding in the background of poverty have been thought to portend a poorer outcome in most developing countries. At Kenyatta National Hospital (KNH), mortality data from the hospital's central records indicated that ARI accounted for 46.5% of total admissions in 2005 and was responsible for 19.8% of all the deaths in the same year.

Diagnosis of Pneumonia

Etiological diagnosis of pneumonia remains a challenge given the variety of microorganisms that cause it, besides co infection with various pathogens do occur [4,5]. Blood cultures and nasal pharyngeal aspirates have been used for bacteria isolation, whereas immunofluorescence of nasal pharyngeal aspirates is used for viral identification. However, high carrier rates have been demonstrated in nasal pharyngeal aspirates. The more specific method of lung aspiration is invasive and hence not routinely

done. Chest radiographs are the gold standard for diagnosis of pneumonia unfortunately they have limited use in etiological diagnosis [6].

In order to reduce pneumonia deaths, World Health Organization (WHO) in collaboration with United Nation Children Fund (UNICEF) created the Integrated Management of Childhood Illnesses (IMCI) strategy to formulate appropriate case management. The strategy uses simple clinical signs and symptoms which form standard guidelines for diagnosis and management of common childhood illnesses. This has been found to be useful especially in the first level health facilities in developing countries where radiology, laboratory, drugs and other health resources are limited [7,8].

WHO guidelines classify pneumonia in terms of clinical severity [9]. In addition to supportive therapy, the guidelines also recommend appropriate antimicrobial therapy for the various classifications of pneumonia (Appendix 1)

1.2 Case definitions

Severe pneumonia: Presence of cough or difficult in breathing with lower chest wall in drawing.

Very severe pneumonia: Presence of cough or difficult in breathing with any of the following danger signs; Central cyanosis, inability to drink or breastfeed, unconsciousness/lethargy or severe respiratory distress such as head nodding.

Hypoxemia: Oxygen saturation of less than 90% as measured by pulse oximeter.

Moderate to severe malnutrition: Weight for height/length less than -2SD

Appropriate initial antibiotic treatment for severe pneumonia: Crystalline penicillin 50,000 1.U/kg/dose I.V/ I.M 6hrly.

Appropriate initial antibiotic treatment for very severe pneumonia: Crystalline penicillin 50,000 I.U /kg/dose I.V/ I.M 6hrly and Gentamycin 7.5mg/kg I.V/ I.M once a day.

Appropriate initial antibiotic treatment for severe pneumonia and malnutrition: As per treatment for very severe pneumonia.

Appropriate initial antibiotic treatment for severe pneumonia and HIV: As per treatment for very severe pneumonia, but in addition, cotrimoxazole (8mg /kg trimethoprim and 40mg/kg of sulfamethoxazole I.V/ oral) in divided doses.

1.3 LITERATURE REVIEW

Factors associated with pneumonia outcome.

A study done in Bangui central Africa identified age below one year (two months to eleven months), presence of chest in drawing, hepatomegally, grunting, as well as acute malnutrition as some of the risk factors for death among children hospitalized with ARI[10]. Another study done in Papua New Guinea showed that cyanosis and poor feeding were strongest predictors of death in children admitted with pneumonia. Age below one year, malnutrition and prolonged illness increased risk of severe disease and of dying [11].

Even though hypoxia is a major risk factor for death in children with ARI in developing countries, oxygen is sometimes not part of first line treatment usually being reserved for most seriously ill children whose outcome is poor [12]. Ideally oxygen should be given to children with hypoxia in early stages of clinical pneumonia to prevent deterioration.

In Kenya, half of the infants and children below three years of age admitted with pneumonia in Kenyatta National Hospital had hypoxemia (oxygen saturation of less than 90%). This study group had short term mortality (within five days of admission) 4.3 times greater than their non hypoxemic counterparts. Respiratory rate of more than seventy per minute, grunting and chest retractions were the best clinical predictors of hypoxemia in under-one-year old children [13].

HIV epidemic has sharply increased the incidence, severity, and mortality due to childhood pneumonia. In South African countries, HIV related pneumonias are the leading cause of admissions in children admitted with ARIs [14]. Bacterial infection

remains a major cause of these pneumonia deaths. In HIV, a broader spectrum of pathogens occurs including gram negative bacteria, *pneumocystis jirovecii* among others. HIV infected children suffer the usual childhood infections more frequently and more severely than uninfected children. These infections may be viral, bacterial or fungal which result in extended hospital stays and malnutrition [14]. Children who are immunosuppressed generally have a higher incidence of bacterial pneumonia [15]. Although the common presentation of HIV infected children with pneumonia may be similar to those of all children addressed by the IMCI, the prevalence of opportunistic infections such as *pneumocystis jerovecii* pneumonia and associated high mortality is a challenge [16]. Bronchiectasis may occur in HIV infected children as a result of severe, unresolving or recurrent pulmonary infections, which eventually lengthen duration of hospital stay as well as causing readmission [17].

Malnutrition is associated with half of the deaths in under-5 years of age. Malnourished children have deranged immune responses and are particularly susceptible to infections including pneumonia which is one of the recognized clinical aspects associated with hospitalization and death [18].

Bacteremia indicates an invasive disease associated with high mortality. In pneumonia, it is present in 1 – 27% of patients' yields being affected by the volume of inoculation and prior use of antibiotics [19, 20]. A study done at Kilifi District Hospital showed that the prevalence of invasive bacterial infection in children admitted with severe pneumonia syndrome was similar to that of mild pneumonia syndrome but case fatality was greater

in the former[21]. HIV infection and malnutrition are independent risks factors for bacteremia, influencing type and amount of bacterial isolates as well as their anti microbial sensitivity [22, 23].

There is concern of emerging bacterial resistance to the commonly used antimicrobial agents. Emergence of cross-resistance among antibiotics has been reported and prevalence of multi drug resistance continues to increase [24, 25]. This may affect the management outcome of bacterial pneumonia. Apart from antibiotics and other supportive care, the ultimate prognosis of pneumonia depends on other factors, some of which have been mentioned above. The extent to which these factors influence the outcome of children admitted with pneumonia at KNH is not known. This study attempts to provide such knowledge.

1.4 STUDY JUSTIFICATION.

The study will provide information that will guide the institution in understanding the clinical characteristics of pneumonia population as well as some of the factors associated with its mortality. This will help in planning for prompt care of patients admitted with pneumonia who are at risk of dying.

1.5 STUDY OBJECTIVES.

Broad objective

To describe short term mortality outcome in children admitted with severe or very severe pneumonia at KNH.

Specific Objectives

1. To determine the association between severity of pneumonia, hypoxemia, HIV, weight for height Z scores, severe dehydration and bacteraemia with short term mortality outcome in children admitted with severe or very severe pneumonia.

2. To describe the initial antibiotic prescribing practices in children admitted with severe and very severe pneumonia at KNH and compare with WHO's treatment guidelines.

2. 0 METHODOLOGY

2.1 Study Site

The study was conducted at the PFC and general paediatric wards of KNH from August 2006 to December 2006. KNH is a national referral and teaching hospital, admitting patients from all over the country with majority coming from Nairobi and its environs. PFC is the clinical unit where sick children first encounter the clinicians, mainly clinical officers with post basic training in paediatrics before admission to the wards or treated as outpatients and discharged home. In paediatric wards, the admitted children are managed by ward clinicians who include medical officer interns, Paediatric Residents, paediatric consultants as well as consultant specialists in various fields of paediatrics.

2.2 Study Population

Children aged between two and 59 months admitted in KNH with a diagnosis of severe or very severe pneumonia according to WHO guidelines [9].

2.3 Study Design

Descriptive cross- sectional study.

2.4 Subject Selection

Inclusion criteria

1. All children aged between two and 59 months admitted with diagnosis of severe or very severe pneumonia based on WHO guidelines.
2. Children whose parents or caregivers consented for participation in the study.

Exclusion criteria

1. Children whose parents or guardians declined consent for participation in the study. The following were additionally excluded for the initial antibiotics prescribing practices part of the study:

2. Readmissions within 14 days of discharge (to avoid recruiting those with possible nasocomial infections).

3. Referral from other health facilities where second line antibiotics had already been initiated.

4. Those who had suspected or confirmed meningitis (initial antibiotics vary from those of pneumonia).

2.5 Sample Size

Sample size to determine mortality outcome was calculated using Fishers formula of prevalence study [26]:

$$N=\frac{Z^2 1\text{-}\alpha/2\ P\ (I\text{-}P)}{d^2}$$

Where N = Sample size

Z = Table value for standard normal deviate approximately significance level of 5% (1.96)

P = Estimated prevalence of mortality due to ARI from previous studies at KNH which is (19.8%)

d = Degree of accuracy set at + or – 5%

Hence substituting these figures in the equation,

$$N = \frac{1.96^2 \times 0.198(1-0.198)}{0.05^2} = 244$$

2.6 Procedures

a. Clinical

All children aged between two and 59 months admitted with a history of cough or difficult in breathing were assessed and severity of pneumonia classified using clinical signs as per WHO case management guidelines as stipulated in the background information. Enrolment in the study was done at PFC emergency room after obtaining a written consent. This recruitment was done by a trained clinical officer who was the research assistant.

Demographic data and clinical history were obtained as per study questionnaire (Appendix II). A thorough but focused physical examination was performed and findings recorded in a precoded questionnaire (Appendix II).

Nutritional status was determined by measuring length/height in centimeters to the nearest 0.5cms, and weight in kilograms to the nearest 100gms. Z scores were determined using WHO/NCHS reference weight-for-length/height tables [9] (Appendix III). Initial antibiotic prescription at PFC was documented. Daily follow up in the wards was conducted to document progress, thus whether dead or alive within a week of admission as well as initial antibiotics prescription on the day of admission. It's worth noting that deaths occurring after one week of admission were not documented since the study focused on one week outcome of pneumonia.

Antibiotics analysis was based on WHO guidelines for treatment of pneumonia.[9]

In this study, the following initial antibiotic dosage ranges were considered appropriate.

1. Crystalline penicillin- 40-60,000I.U/kg/dose 6 hourly. Due to the wide safety margin of penicillin's, dosages above the study's limit were considered adequate.

2. Gentamycin – 6.5-8.5mgs/kg/day once a day.

b. Oxygen saturation

Patient's transcutaneous haemoglobin oxygen saturation was measured while calm and breathing at room air using a portable pocket Nonin pulse oximeter via placement of its probe on a toe or a finger. First reading was taken after 5 seconds following a recording of a standard waveform on the pulse oximeter which was an indicator of good peripheral circulation. A second reading was taken 5 seconds apart and the average of the two readings documented as the patient's oxygen saturation. Children who had cold extremities were kept warm prior to taking their oxygen saturation. Hypoxemia was defined as oxygen saturation less than 90% this was based on previous studies which showed high mortality in children with oxygen saturation less than 90%[13, 27&28]. This cutoff oxygen saturation level is the standard used by WHO guidelines [9].

c. HIV Counseling and testing.

All children were tested for the presence of antibodies to HIV. Pretest counseling to the parents was done prior to collection of blood .The parallel testing method with rapid kits of Bioline and Determine which detect antibodies to HIV-1 and HIV-2 in human whole blood were used to assess HIV serostatus. Using this method, patient was considered to be HIV seropositive if both tests were positive or was considered negative when both tests were negative. However if the two kits showed discordant results then blood was

taken for confirmatory test using Enzyme Linked Immunorsorbent Assay (ELISA) from Dade Behring Inc. For children below 18 months, if rapid test was positive, a confirmatory HIV antigen Polymerase Chain Reaction (PCR) test was done. This was done at KEMRI laboratory by dr Khamadi during the course of the study.

Upon obtaining results of HIV status, parents of the children were informed following post test counseling. The child's primary clinician was also informed of the result to assist in further management of the patient.

d. Collection of specimens

(i) Blood

The venepuncture site was cleaned with 70% alcohol and 10% povidone iodine. A 2cc syringe and gauge 22- hypodermic needle were used to draw blood. The injection site on the cap of the culture bottle was similarly disinfected before inoculation using a fresh sterile needle. Utmost care was upheld to avoid contamination.

Two milliliters of blood were obtained by venepuncture: one milliliter was inoculated into a culture bottle provided by KEMRI Wellcome Trust Research Laboratories with standard blood culture broth as described above. The remaining 1 ml was placed in an EDTA bottle and sent to KEMRI virology laboratory for PCR test for children aged less than 18 months whose rapid tests for HIV was reactive. Specimens were transported to the respective laboratories within an hour of collection.

(ii) Cerebral spinal fluid

Children who apart from having respiratory signs and symptoms had features suggestive of meningitis such as bulging fontanels, stiff neck or seizures had a lumbar puncture (LP) done. Strict aseptic condition was upheld. The procedure involved the child to lie on the side and third or fourth lumbar interspaces were identified. A sterile gauge 22 needle was used to collect approximately 0.5 milliliter of CSF in a sterile plain bottle. L.P was deferred if a child required emergency resuscitation, pupils responded poorly to light or other signs of cerebral edema as well as presence of skin infection at the L.P site. Specimens were delivered to the laboratory within an hour after collection.

2.7 Laboratory Methods

1. Blood Culture

Once delivered to the laboratory, specimen of blood was incubated at 37^0 C sampling from culture bottles and subsequent plating an sheep blood agar, chocolate agar and Macconkeys agar was done regularly at 24, 48 and 72 hours. In case of a growth, the isolates were processed using standard bacteriologic techniques consisting of colony, morphology, gram stain, catalase, oxidase and other biochemical identification tests [29]. Specimen was declared sterile if no growth was seen after 72hrs of incubation. Antibiotic sensitivity testing against routinely available antibiotics was done using antibiotic discs.

2. CSF Culture

CSF from the sterile specimen bottle was inoculated into culture plates after centrifuging at 3000 resolutions per minute for 10 minutes. The sediment was inoculated using sterile wire loop into chocolate, blood and Macckonkey agar plates which was incubated at 35 -

37^0 C overnight. If no colonies identified, the plates were re incubated and read every 24hours over 72hours. Incase of a growth the isolates were identified by standard bacteriological technique as described above in blood culture technique. In this study, Coagulase negative staphylococci (CoNS) were considered as commensals and hence not included in the results and subsequent analysis.

3. HIV ELISA assay

ELISA for HIV antibodies was performed on children with discordant rapid test results. 1 ml of blood was centrifuged for 10 minutes and the separated serum tested for the presence of HIV 1 & 2 using the enzyginost anti-HIV 1&2 plus kit by Dade Behring Inc. The PCR blood testwas done on a blotting paper at KEMRI Virology laboratory.

2.8 DATA ANALYSIS

Data was entered into pre coded questionnaires (Appendix II); Z-scores for nutritional status were determined using WHO/NCHS reference tables (Appendix III).Data was double entered in the computer on collection, cleaned and analyzed using Statistical Package for Social Sciences (SPSS) program. Descriptive statistics including rates and percentages were determined in the analysis. Children were classified according to severity of pneumonia (severe or very severe) and categorized according to outcome at seven days after admission (dead or alive). Differences between the two groups were assessed using chi-square test, student's t-test and Fisher's exact test as appropriate. Odds ratio whose corresponding 95% CI was calculated. This was applied in univariate analysis.

Multivariate analysis using Binomial Logistic Regression was used to determine the significant factors associated with mortality. Binomial logistic regression was considered to be the best analysis technique due to the fact that it can be applied regardless of distribution of the significant variables, that is, the significant variables do not have to be normally distributed, linearly related or of equal variance within each group. Further, it is much suited for an analysis where the outcome or the response of interest takes a binary or dichotomous form which in this study is either 'alive' or 'dead'. The results were presented in descriptive form using frequency tables, pie charts, graphs and cross tabulation.

2.9 ETHICAL CONSIDERATION

Informed consent was free and voluntary and parents or guardians were allowed to withdraw at will.

Priority was given to resuscitation of patients with respiratory or cardio respiratory compromise.

The study protocol was approved by KNH – Ethical and Research Committee.

Results of HIV, blood and CSF were availed to the primary clinician as soon as they became available.

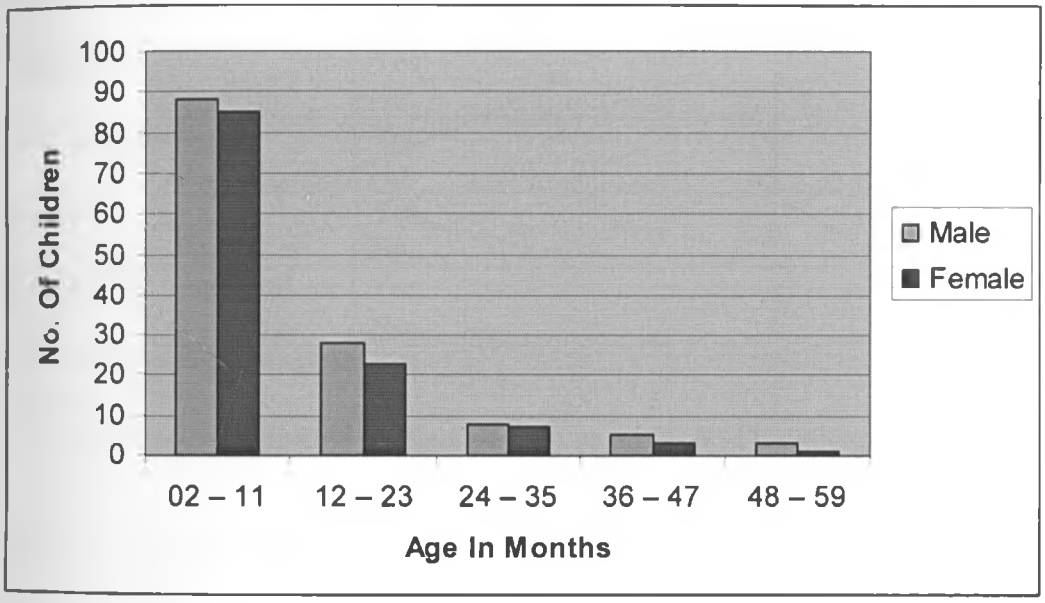
Confidentiality was maintained as explained in the consent form.

3.0 RESULTS.

3.1 Description of the study population

A total of 251 patients met the inclusion criteria and were recruited over a period of five months August 2006 to December 2006. There were 132 (52.6%) males and 119 (47.4%) females giving a male to female ratio of 1:0.9.The median age of study participants was 8months (range 2 months to 59 months).

Figure 1: Distribution of Children Studied by Age and Gender



Sixty nine percent of patients admitted with diagnosis of severe pneumonia were aged below 1 year while only 11% were aged over 2 years (figure 1).

The gender distribution was almost similar in all age groups for example, in those below one year, 88 were males, and 85 were females, likewise in those between two years and three years, 8 were males and 7 were females (figure 1).

Table.1 Baseline characteristics of study population.

Group.	Characteristic.	Total N=251	Percentage.
Duration of illness in days [b]	Median	5 (1-21)	
Severity of pneumonia.	Very severe. Severe.	73 178	29.1 % 70.9 %
Oxygen saturation.	Hypoxia. No hypoxia.	125 126	49.8 % 50.2 %
HIV status.	Positive. Negative.	47 204	18.7 % 81.3 %
Nutritional status.	Malnutrition (W/H Zscore<-2SD). Normal (W/H Zscore >-2SD)	73 178	29.1 % 70.9 %
Dehydration.	Severe. Some or none.	14 237	5.6 % 94.4 %
Bacteremia.	Yes. No.	14 237	5.6 % 94.4 %
Central cyanosis.	Yes. No.	9 242	3.6 % 96.4 %
Grunting.	Yes. No.	71 180	28.3 % 71.7 %
Inability to breastfeed or drink.	Yes. No.	62 189	24.7 % 75.3 %
Referred from other health facilities.	Yes. No.	103 148	41 % 59 %

[b]–Longest reported duration of illness cough or difficult in breathing.

Duration of illness ranged from 1 to 21 days with a median of 5 days. Of the children admitted with severe pneumonia, 29% had very severe pneumonia, 49.8% had hypoxia,19% were HIV infected, and 29% had moderate to severe malnutrition (<-2SD weight for height).

A small proportion had severe dehydration (6%), bacteraemia (6%) and cyanosis (3.6%). Inability to breastfeed or drink accounted for 24.7%, whereas 28% of the study population presented with grunting. Prior to hospitalisation, 41% of children admitted with pneumonia had visited other health facilities as evidenced by referral letters (table1).

Oxygen saturation in patients admitted with pneumonia.

Hypoxemia was defined as oxygen saturation of <90%. Oxygen saturation of study population ranged from 31% to 100%.

Figure 2: Oxygen Saturation in children admitted with pneumonia.

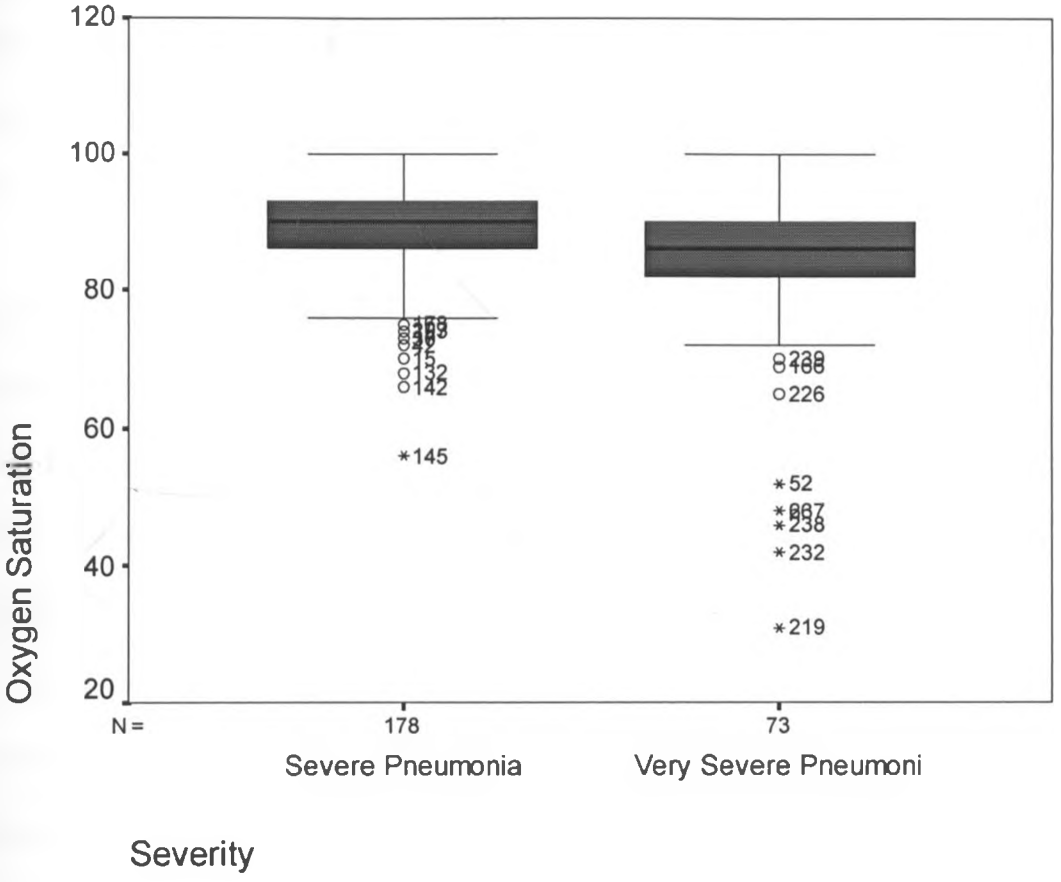


Figure 2 shows a box and whisker plot showing comparison of median and spread of oxygen saturation between children admitted with severe pneumonia and those with very severe pneumonia. The median oxygen saturation in children admitted with very severe pneumonia was 85% (range of 31% to 100%), whereas the median oxygen saturation for those with severe pneumonia was 90% (range of 58% to 100%).

Table 2: Distribution of patients according to categories of oxygen saturation

0xygen saturation	Number.	Per cent (%
>95%	37	14.7
90-94%	89	35.5
85-89%	60	23.9
<85%	65	25.9

Of the children admitted with pneumonia, 25.9% had severe hypoxia (oxygen saturation less than 85%), whereas 23.9% had mild to moderate hypoxia (oxygen saturation of 85-89%).

Bacterial isolates from blood culture and CSF.

In total 14 bacterial pathogens were isolated via blood culture, giving a bacteremia yield of 5.6%. *Strep pneumoniae* (2), *Staph. Aureus* (1) were the gram positive bacteria isolates, whereas *Klebsiella* (3), *E.Coli* (3), *Salmonella* species (2), *pseudomonas* (1), *citrobacter* (1), and *Enterococcus* (1) formed the gram negative isolates.

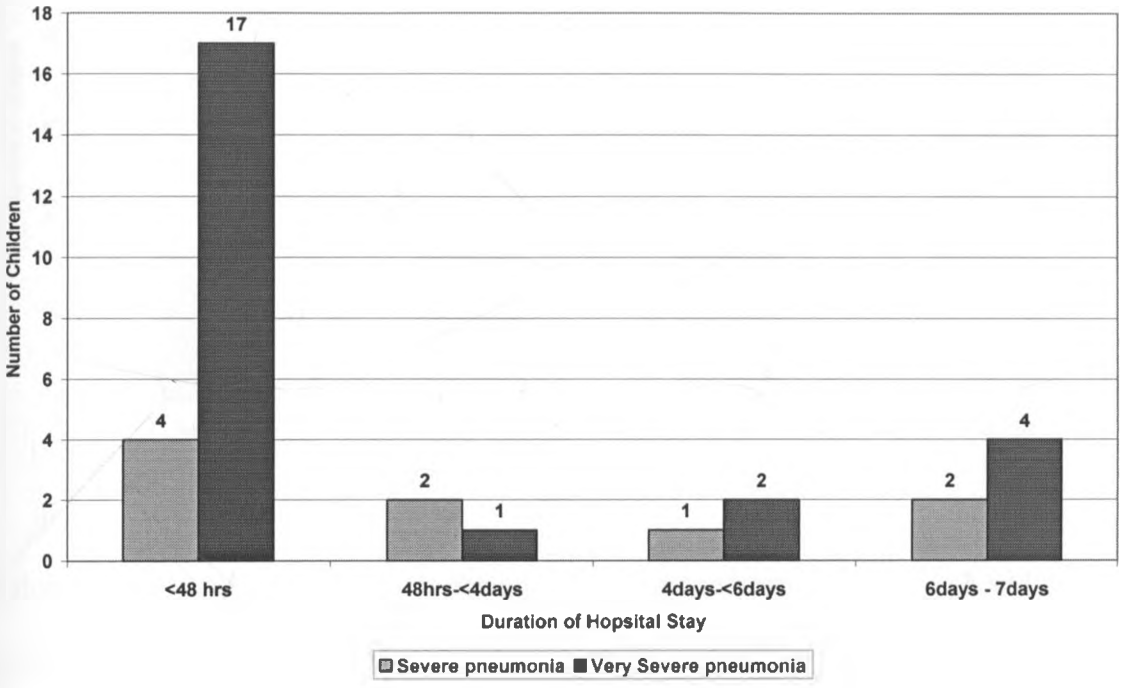
Of the bacteremic children, 8 (57%) were HIV infected.

Nineteen patients were admitted with suspected meningitis; however only two had bacterial culturepositive CSF (Citrobacter (1), *Strep.pneumoniae* (1))

3.2 Seven-Day Outcome of Pneumonia.

Of the 251 children admitted with pneumonia, 33 died within one week of admission giving a short term mortality rate of 13.2% of whom 17 were males and 16 were females, M: F ratio 1.1:1.

Figure 3: Time from admission to death among children dying of pneumonia

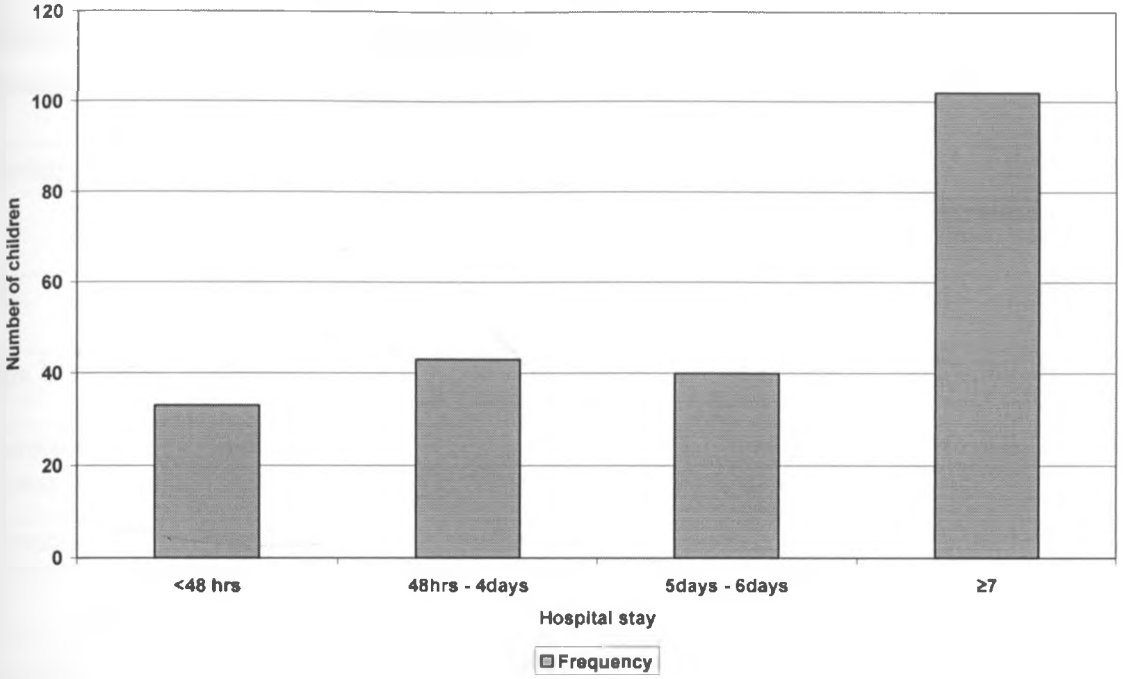


The mean number of days spent in hospital for the children who died was 2.5 days with a mode of 0 days (within 24 hrs of admission).

Most of deaths (63.6%) occurred within 48hours of admission, 57.1% (12) of whom died within 24 hours of admission. Of these early deaths, 17(81%) had very severe pneumonia. In general mortality within one week of admission was higher (72.7%) among children admitted with very severe pneumonia compared with those with severe pneumonia (figure 3).

On the other hand, the average length of hospital stay for those who survived was found to be 5.2 with a mode of 7 days as shown in figure 4;

Figure 4: Duration of hospital stay among survivors of pneumonia.



Majority (46.3%) of survivors of pneumonia stayed in the hospital for a week and beyond, whereas only 12.4% of those who survived were discharged in less than 48 hours of admission.

Factors influencing mortality.

Association of short term outcome of pneumonia with patients' demographic and clinical characteristics was determined using univariate and multivariate binomial logistic regression and the results are as shown in table 3.

Table 3: Factors associated with pneumonia mortality-univariate analysis

Group.	Characteristic.	Dead. N=33	Total No.	OR (95%CI)	P val
Sex.	Male. female	17 (12.9%) 16 (13.4%)	132 119	1.0(0.5-2.2)	0.894
Age in months.	Median	8 (2-42)	8 (2-60).	1.0(0.9-1.0)	0.332[a]
Duration of illness in days.	Median	7(1-21)	5(1-21)	1.1(1.0-1.1)	0.067[a]
Severity of pneumonia.	Very severe. Severe.	24 (32.9%) 9 (5.1%)	73 178	9.2(4.0-21.1)	0.000
Oxygen saturation.	Hypoxia. No hypoxia.	23 (18.4%) 10 (7.9%)	125 126	3.1(1.4-7.0)	0.006
HIV status.	Infected. Non Infected.	21 (44.7%) 12 (5.9%)	47 204	13.0 (5.7-29.3)	0.000
Nutritional status.	Malnutrition (<-2SD). Normal (>2SD)	17 (23.3%) 16 (9.0%)	73 178	3.1(1.5-6.5)	0.003
Dehydration.	Severe. Some or none.	5 (35.7%) 28 (11.8%)	14 237	4.2(1.2-14.5)	0.024
Bacteremia.	Yes. No.	4 (28.6%) 29 (12.2%)	14 237	2.9(0.8-9.8)	0.095
Cyanosis.	Yes. No.	4 (44.4%) 29 (12.0%)	9 242	5.9(1.5-23.1)	0.020
Grunting.	Yes. No.	16 (22.5%) 17 (9.4%)	71 180	2.8(1.3-5.9)	0.007
Inability to breastfeed or drink.	Yes. No.	20 (32.3%) 13 (6.9%)	62 189	6.5(3.0-14.0)	0.000
Referred.	Yes. No.	12 (11.7%) 21 (14.2%)	103 148	1.1 (0.5-2.3)	0.785.

[a] - student's t-test.

In univariate analysis, children who had HIV infection had 13 times odds of dying (OR 13.0 CI 5.7-29.3) than those who were not HIV infected. Similarly those who had very severe pneumonia had 9 times odds of dying (OR 9.2 CI 4.0-21.1) compared to those with less severe pneumonia. Mortality was also increased by 6.5 times (OR 6.5 CI 3.0-14.00) in children with inability to breastfeed or drink compared to ones who were able to feed. Central cyanosis was associated with 6-fold increase in the odds of death (OR 6.0 CI 1.5-23.1), compared to those without cyanosis whereas those with severe dehydration had 4 times odds of dying (OR 4.15 CI 1.2-14.5) compared to those who had some dehydration or good hydration status. Children who had hypoxia had 3 fold odds of dying (OR 3.1 CI 1.4-7.0), similarly those who had moderate to severe malnutrition based on weight for height Z scores carried 3 times odds of dying (OR 3.1 CI 1.5-6.5) compared to children with mild wasting or normal nutrition status. Children presenting with grunting were almost 3 times likely to die as compared to those without grunting (OR 2.8 CI 1.3-5.9). Even though bacteraemia was associated with death (OR 2.9 CI 0.8-9.8), this was not statistically significant, p value 0.095. Child's age, gender, duration of illness, or being referred from other health facilities did not affect the seven-day mortality outcome of pneumonia.

3.3 LOGISTIC REGRESSION ANALYSIS.

Binomial logistic regression was used as a tool in the multivariate model to help determine independent factors associated with the short term mortality outcome of the pneumonia. The analysis began with a full or saturated model with all the clinical and laboratory variables included. Table 4 shows the results obtained.

Table 4; Variables in the initial analysis

Step 1	B	Sig.	95.0% C.I.of odds ratio
Variable			
Hypoxemia	0.016	0.977	0.3 - 3.0
Malnutrition	0.481	0.724	0.1 - 23.3
Cyanosis	-0.401	0.773	0.0 - 10.2
Grunting	0.089	0.889	0.3 - 3.8
Audible wheeze	0.376	0.805	0.1 - 29.0
Severe Respiratory Distress	0.426	0.547	0.4 - 6.1
Lower chest in drawing	-5.711	0.954	0.0 - 22.2
Inability to breastfeed or drink	1.429	0.010	1.4 - 12.3
Severe dehydration	1.813	0.014	1.4 - 26.0
Capillary refill	-0.032	0.928	0.5 - 1.9
Nature of peripheral pulse	0.167	0.542	0.7 - 2.0
Severe palmar pallor	0.286	0.821	0.1 - 15.9
Visible severe wasting	-0.560	0.680	0.0 - 8.2
Hepatomegally	0.599	0.444	0.4 - 8.4
Splenomegally	2.053	0.332	0.1 - 29.3
Gallop rythym	-7.693	0.886	0.0 - 2.7
AVPU	-0.362	0.546	0.2 - 2.3
Bacteremia.	-0.987	0.297	0.1 - 2.4
HIV	2.563	0.000	4.3 - 38.8
Constant	2.205	0.982	

The model was then improved through the backward stepwise elimination binomial logistic regression technique, whereby, variables with least contribution were eliminated from the model in an iterative process.

The Wald Chi-square test statistic was used to determine the variable to be eliminated at each stage of the iteration until a model with only significant variables was obtained. The likelihood-ratio test and the Hosmer and Lemeshow test were used to test the suitability of the model at each stage. The final results of the analysis are shown on Table 5

Table 5: Factors associated with pneumonia mortality- Multivariate logistic regression analysis.

Variable	B	Sig	95.0% Confidence interval for the OR	
			Lower	Upper
Inability to breastfeed or drink	1.499	.002	1.760	11.386
Severe dehydration	1.908	.000	2.347	19.347
HIV	2.539	.000	4.858	33.017
Constant	-3.828	.000		

HIV (p value 0.000), severe dehydration (p value 0.000) and inability to drink or breastfeed (p value 0.002) were highly associated with mortality in the multivariate regression analysis.

The likelihood-ratio test and the Hosmer and Lemeshow test showed that this final model was adequate since it could predict 92 percent of the cases correctly.

3.4 Factors influencing severity of pneumonia

Factors associated with severity of pneumonia were determined by univariate analysis (table 6).

Table 6: Factors associated with severity of pneumonia-univariate analysis

Group.	Character.	Very severe pneumonia, N=73	Severe pneumonia. N=178.	OR(95%CI)	P value.
Sex.	Male. Female.	36 37	96 82	0.8(0.5-1.4)	0.506
Age.	Median (range)	8(2-46) mo	8(2-60)	1.0 (0.9-1.0)	0.069
Referred.	Yes. No.	43 30	60 118	2.6(1.5-4.6)	0.001
Oxygen saturation.	Hypoxia. No hypoxia.	50 23	75 103	3.0 (1.7-5.3)	0.000
HIV status.	Positive. Negative.	28 45	19 159	5.2(2.7-10.2)	0.000
Nutritional status.	Underwt(<-2SD) Normal(>-2SD)	28 46	45 137	1.9(1.0-3.3)	0.004
Dehydration.	Severe. Some or no dehydration.	6 67	8 170	1.7(0.6-4.9)	0.342
Bacteremia.	Yes. No.	8 55	6 172	4.2(1.4-12.5)	0.001

Children who are referred had 2.6 odds of having very severe pneumonia (OR 2.6 CI 1.5-4.6) compared to non referral ones, while those who were HIV infected had a 5 times odds of having very severe pneumonia (OR 5.2 CI 2.7-10.2) compared to non infected ones. Children who were hypoxic were 3-fold higher odds of having very severe pneumonia (OR 3.0 CI 1.7-5.3) compared to non hypoxemic ones. Bacteraemia too was highly associated with very severe pneumonia (OR 4.2 CI 1.4-12.5).

Malnutrition (<-2SD weight for height) had a marginal risk of very severe pneumonia (OR 1.9 CI 1.0-3.3). Although risk of very severe illness was increased in children with severe dehydration (OR 1.7 and 1.1 respectively), it did not achieve statistical significance (p value 0.342). Age and sex were not associated with very severe pneumonia (OR 1 CI 0.9-1.0), (OR 0.8 CI 0.5-1.4) respectively.

Inability to feed, central cyanosis, severe respiratory distress and grunting were not subjected to univariate analysis since they formed the clinical basis of diagnosis of pneumonia. Multivariate logistic regression was also not done to determine factors associated with severity of pneumonia since the clinical variables to be included in the model as in case of mortality above were used in diagnosis of various severity levels of pneumonia.

Initial antibiotic prescriptions

In total 53 (72.6%) of children admitted with very severe pneumonia and 144 (80.9%) of children admitted with severe pneumonia had documented initial antibiotic prescriptions table 7.

We recognize that the sample size for analysis of initial antibiotic prescribing practises was inadequately powered hence the inferences made hereafter may not be representative. In this study none of the gentamycin dosage was above the study's limit.

Table 7: Initial antibiotics prescription for children admitted with pneumonia

Severity of pneumonia	PFC NO. (%)	Ward NO. (%)	P-Value
Severe pneumonia N=144			
Appropriate choice -			
Yes	47 (33%)	58 (40%)	
No	97 (67%)	86 (60%)	0.221
Adequate dose X-pen			
Yes	110 (76%)	127 (88%)	0.103
No	34 (24%)	17 (12%)	
Adequate dose Genta			
Yes	128 (89%)	131 (91%)	0.696
No	16 (11%)	13 (9%)	
Very severe pneumonia N=53			
Appropriate choice -			
Yes	51(96%)	49 (93%)	
No	2 (4%)	4 (7%)	0.678
Adequate dose X-pen			
Yes	43 (81%)	47 (87%)	0.417
No	10 (19%)	6 (13%)	
Adequate dose Genta			
Yes	48 (91%)	46 (87%)	
No	5 (9%)	7 (13%)	0.761

Of the 144 children admitted with severe pneumonia whose antibiotic prescriptions were analysed, 67% did not receive appropriate choice of antibiotics at PFC and similarly 60% had inappropriate antibiotics prescription in the wards, though the difference was not statistically significant p value 0.221. Inadequate dosages for crystalline penicillin were noted both at PFC (24%) and wards (12%) though the difference was not statistically

significant p values 0.103. Similarly under doses of gentamycin were noted both at PFC (11%) and in the wards (9%) though the difference was not statistically significant p value 0.696 table 7.

Of the 53 children admitted with very severe pneumonia whose antibiotic prescriptions were analysed, 4% and 7% had inappropriate choice of antibiotics prescribed at PFC and in the wards respectively. This was not statistically significant p value 0.698. Inadequate dosing for crystalline penicillin was noted at PFC (19%) and in the wards (13%) but the difference was not statistically significant p value 0.417. Similarly under dosing was noted for gentamycin both at PFC (9%) and in the wards (13%) though the difference was not statistically significant p value 0.761, table 7.

3.5 Initial antibiotics use in children admitted with pneumonia and moderate to severe malnutrition.

In total 56 children admitted with pneumonia and moderate to severe malnutrition met the inclusion criteria for initial antibiotic prescription analysis, 36 had severe pneumonia and 20 had very severe pneumonia table 8.

Table 8: Initial antibiotics prescription for children admitted with pneumonia and moderate to severe malnutrition

Pneumonia with malnutrition.	PFC NO. (%)	Ward NO. (%)	P-Value
Severe pneumonia N=36 Appropriate choice - Yes No Adequate dose X-pen Yes No Adequate dose Genta Yes No	 32 (89%) 4 (11%) 30 (83%) 6 (17%) 33 (92%) 3 (8%)	 34 (94%) 2 (6%) 32 (89%) 4 (11%) 30 (83%) 6 (17%)	 0.674 0.735 0.478
Very severe Pneumonia N=20 Appropriate choice Yes No Adequate dose X-pen Yes No Adequate dose Genta Yes No	 19(95%) 1 (5%) 18 (90%) 2 (10%) 17 (85%) 3 (15%)	 16 (80%) 4 (20%) 19 (95%) 1 (5%) 18 (90%) 2 (10%)	 0.342 1.000 1.000

Of the 36 children admitted with severe pneumonia and malnutrition, 11% did not receive appropriate choice of antibiotics at PFC and similarly 6% had inappropriate antibiotics prescription in the wards, but the difference was not statistically significant p value 0.674. Inadequate dosages for crystalline penicillin were noted both at PFC (17%) and wards (11%) though the difference was not statistically significant p values 0.735. Similarly under doses of gentamycin were noted both at PFC (8%) and in the wards (17%) though the difference was not statistically significant p value 0.478 table 8.

Of the 20 children admitted with very severe pneumonia and malnutrition, 5% and 20% had inappropriate choice of antibiotics prescribed at PFC and in the wards respectively. This was not statistically significant p value 0.342. Inadequate dosing for crystalline penicillin was noted at PFC (10%) and in the wards (5%) but the difference was not statistically significant p value 1.000. Similarly under dosing was noted for gentamycin both at PFC (15%) and in the wards (10%) though the difference was not statistically significant p value 1.000 (table 8).

Cotrimoxazole use in HIV infected children admitted with pneumonia.

In total 47 (18.7%) children admitted with pneumonia were HIV infected of whom 28 (60%) had very severe pneumonia and 19(40%) had severe pneumonia.

Table 9: Cotrimoxazole prescription in HIV infected children admitted with pneumonia

Cotrimoxazole dosing	Very severe pneumonia	Severe pneumonia	Total (%)
Prophylaxis.	8 (28.6%)	13 (68.4%)	21 (44.7%)
PCP treatment	5 (17.9%)	3 (15.8%)	8 (17.0%)
No prescription.	15 (53.6 %)	3 (15.8%)	18 (38.3%)
Total	28	19	47 (100%)

Of the HIV infected children, only 5(18%) who had very severe pneumonia and 3 (16%) who had severe pneumonia obtained appropriate cotrimoxazole prescription for PCP treatment. However inappropriate cotrimoxazole prescription for prophylaxis against PCP was noted both in children admitted with very severe pneumonia (27%) and severe pneumonia (68%). Thirty eight percent of HIV infected children missed a prescription of cotrimoxazole drug, majority (53.6%) of whom had very severe pneumonia (Table 8). Of the children with very severe pneumonia who missed cotrimoxazole's prescription, 80% died within the first 24 hours of admission.

4.0 DISCUSSION

This study focused on one week's mortality outcome following admission of children aged two to 59 months with diagnosis of severe pneumonia or very severe pneumonia.

The mean age of the study population was 11 months, in keeping with the observation that severe forms of ARI are common in younger children especially those below one year [30, 31]. Sixty nine percent of study population was aged below one year this was similar to a previous study done at KNH [32].

The classification of pneumonia was based on WHO's guidelines which relies on clinical signs and symptoms [9]. Twenty nine percent of our study population had the very severe pneumonia. This was higher than figures at Kilifi district hospital where 11% of study participants had very severe pneumonia and 52% had severe pneumonia[21]. This could be due to the fact that KNH is a referral hospital and 41% of our study population had been referred from other health facilities hence patients are likely to be sicker on admission compared to a district hospital.

Earlier local studies showed case fatality rate due to pneumonia as 20% since early 1980s [32]. This has remained unchanged as indicated in Malawian pneumonia's case fatality rate of 22% [33]. In our study, mortality rate in children admitted with pneumonia was 13.7% which was lower than expected and this was due to the limitation of short follow up period of one week post admission. However this is comparable to a previous local rate whose short term mortality outcome (5 days) in children admitted with ARI was 10%, though the study age group was 2 months to 3 years [13]. Sixty three percent of deaths occurred within 48hrs of admission in our study implying that pneumonia being an acute illness, aggressive therapy is required in order to avert these deaths.

Survivors of pneumonia were admitted for a week or longer. This has cost implications due to the prolonged bed occupancy in terms of resource utility and as such, possible issues resulting in this scenario would need to be addressed in order to reduce cost of in-patient care.

. In our study HIV infection was noted in 18.7% of the study group. HIV was associated with severity of pneumonia (OR 5.2 CI 2.7-10.2) in univariate analysis and highly associated with mortality OR 12.9(CI 5.7-29.3) in multivariate analysis. This rate was lower than in the South Africa whose HIV infection rate among children admitted with lower respiratory tract infections was 45.1% with a case fatality of 13.1%, (Adjusted Odds Ratio (AOR) 6.52 CI 3.53-12.05[22].

Even though our study did not investigate pneumocystis *jirovecii*, 38% of HIV infected children were not put on cotrimoxazole treatment, 80% of whom died within 24 hours of admission, implying a possibility of PCP related deaths. Other studies too support HIV as a prognostic indicator of childhood pneumonia [22, 31-34]

Hypoxemia is another recognisable cause of morbidity and mortality in childhood pneumonia. In our study hypoxemia was assessed via a portable pulse oximeter, which has been shown to be a reliable, non invasive and accurate method of measuring oxygen saturation [35, 36]. In our findings, almost half of the study population had hypoxemia (oxygen saturation of less than 90%) implying need for constant and effective oxygen supply for supportive care of children admitted with pneumonia. This was similar to a previous local study [13] though different from Indian rate of 38.7% among children admitted with pneumonia [28]. Hypoxemia was significantly related to severity (OR 3.0 CI 1.7-5.3) and mortality (OR 3.1 CI 1.4-7.0) in children admitted with pneumonia and this

is supported by similar findings in other studies [12, 32]. Cyanosis is the most specific clinical indicator of oxygen desaturation, but has been shown to have a maximum sensitivity of 42% [28], thus in our study half of the patients admitted with pneumonia had hypoxia and only 4% had cyanosis. This rarity of cyanosis in African children with ARI was also observed in Bangui Central Africa Republic (2%) [10] possibly because the presence of cyanosis might be obscured in dark-skinned individuals. This underscores the use of pulse oximeter to determine hypoxia other than relying on cyanosis which may be a late sign. In our study cyanosis was associated with mortality OR 5.9(C.I 1.5-23.1) this was similar to the findings in New Guinea [11].

Severe malnutrition has been shown to portend poor outcome in children with ARI [37]. Acute malnutrition was shown to increase risk of death in children admitted with pneumonia in Central Africa republic, [10].In our study, 29.1% of children admitted with pneumonia were malnourished. This was lower than earlier local findings (72%) although pneumonia diagnosis in that study was radiological based and nutritional status was by weight for age hence stunting could have been misclassified as malnutrition. Malnutrition in our study was associated with severity but did not influence mortality after multivariate logistic regression which was similar to the study in New Guinea[11].

Inability to breastfeed or drink was found in 25% of our study group. It was however highly associated with mortality OR 4.5 CI (1.8-11.4) in multivariate model, this was again similar to the study in New Guinea [11].

Bacteremia was significantly related to severity but had no effect on mortality. Our bacterial yield however was low (5.6%) and this may be due to the fact that KNH being a

referral hospital, most of the patients had used antimicrobials before presenting to the unit either from referring facilities or over the counter self medication.

Severe dehydration was associated with mortality in multivariate analysis, OR 6.7(CI 2.3-19.3). Possible explanation would be due to associated poor circulation in already compromised ventilation, leading to poor oxygen delivery and eventual respiratory failure. Severely dehydrated patients also have poor feeding hence lack energy to support the already increased work of breathing as occurs in pneumonia.

Other factors associated with poor outcome included grunting which indicates severe respiratory compromise. Locally, grunting was shown to be the best clinical predictor of death in patients admitted with severe pneumonia who had hypoxia [32]. In our study, grunting was associated with death in children admitted with pneumonia though it was not the most significant factor.

Although initial antibiotic analysis was underpowered to give conclusive report, cases of inappropriate choice of antibiotics as well as under dosages were noted in all classes of pneumonia both at PFC and in the wards. Of the initial antibiotic prescription analysed, 67% of children admitted with severe pneumonia had inappropriate choice of antibiotics at PFC. Twenty percent of children admitted with pneumonia and malnutrition had inappropriate choice of antibiotics in the wards. Inadequate dosage of crystalline penicillin was noted in 24% of children admitted with severe pneumonia at PFC and in 13% of children admitted with very severe pneumonia in the wards. Gentamycin was also under dosed in 13% of children admitted with very severe pneumonia in the wards just to mention a few. As earlier noted, use of cotrimoxazole for treatment of *Pneumocystis jerovecii* pneumonia in 38% of the HIV infected children admitted with pneumonia was

omitted in the initial antibiotic prescriptions. Some children however were put on prophylaxis dose of cotrimoxazole, yet the WHO guidelines advocate for use of treatment doses in all HIV infected children admitted with severe pneumonia. The difference between initial antibiotic prescriptions between PFC and wards was not statistically significant. Local guidelines on antimicrobial prescription would therefore be essential both at PFC and in the wards. Constant review of prescriptions by the clinicians is advisable in order to correct any possible inappropriate medication for optimal care of patients.

5. 0 STUDY LIMITATION

Our study being a short term outcome of pneumonia did not reflect the eventual mortality due to ARI in children admitted at KNH since some of the deaths occurred after one week of admission.

The study design being cross-sectional survey has a limitation of internal validity hence not powered to conclusively evaluate risk factors associated with mortality due to pneumonia.

6.0 CONCLUSIONS

1. The short term mortality outcome of children admitted with pneumonia was 13.2% of whom 72.7% had very severe pneumonia and 27.3% had severe pneumonia. Most of deaths (64%) occurred within 48hours of admission, 57% of whom died within 24 hours of admission. Aggressive and timely interventions are needed in order to reduce mortality due to pneumonia.

2. Inappropriate choice as well as inadequate doses of initial antibiotics was noted in children admitted with pneumonia both at PFC and in the wards, for instance 67% of children admitted with severe pneumonia had inappropriate choice of antibiotics at PFC. Inadequate penicillin dose was noted in 13% of children admitted with very severe pneumonia in the wards. Gentamycin was also under dosed in 13% of children admitted with very severe pneumonia in the wards. Of the HIV infected children, only 17% received appropriate cotrimoxazole's prescription for *Pneumocystis jerovecii* pneumonia treatment, 38% did not get cotrimoxazole prescription 80% of whom died within 24 hours of admission.
3. HIV ($p < 0.001$), severe dehydration ($p < 0.001$) and inability to drink or breastfeed (p 0.002) were the major factors significantly associated with pneumonia mortality. Hence prompt and effective supportive therapy in feeding and fluids administration might reduce mortality due to pneumonia

REFERENCES.

1.Bryce J, Boschi Pinto C, Black R.E et al. WHO estimates of causes of death in children.*Lancet* 2005; 365: 1147-52

2. Williams G. Brian, Boschi-Pinto C, Dye C, et al. Estimates of worldwide distribution of child deaths from ARI. *Lancet Infect Dis* 2002; 2: 25 – 32

3.Chretien J, Murray J, Woolcock A. et al. Acute respiratory infections in children: a global public health problem. *New England Journal of Medicine* 1984; 318: 382-4.

4.Behran, Kliegman, Jenson. Nelson Textbook of Pediatrics 17th edition page 1433

5.Wafula E.M, Ndinya Achola J.O, Pamba A et al. Etiology of acute respiratory infections in children aged below 5 years in Kenyatta National Hospital. *East Africa Medical Journal* 1985; 62: 757

6. Wafula E .M, Ngamau D.W, Muruka F.J et al. X-ray diagnosable pneumonia in children with severe malnutrition at KNH. *East Africa Med. Journal* 1998; 75(10):567-71.

7. IMCI chart booklet. Geneva: WHO; 1995. Available at: http://www.who.int/child-adolescent-health/New_publications/IMCI/chart booklet.pdf

8. Simoes E.A, McGrath E.J, Black R.E et al. Recognition of pneumonia by primary health care workers in Swaziland with a simple clinical algorithm. *Lancet* 1992; 340(8834-35): 1502-3.

9. Pocket book of hospital care for children: guidelines for the management of common illnesses with limited resources. 2005 WHO, page 69-82

10. Demers A.M, Morency P, Jaffar S. et al To identify risk factors for death among children hospitalized because of ARI in Bangui, central Africa. *Paediatric Infect Dis J* 2000; 19(5): 424 – 32

11. Spooner V, Tulloch .S, Alpers M. et al Clinical signs and risks factors associated with pneumonia in children admitted with pneumonia at Goroka hospital, Papua New Guinea. *J. Trop Pediatr* 1989; 35: 295-300

12. Dyke T and Brown N. Hypoxia in childhood pneumonia better detection and more oxygen needed in developing countries. *BMJ* 1994; 308: 119 – 200.

13. Onyango F E, Wafula E.M, Kitonyi J et al. Hypoxemia in young Kenyan children with acute lower respiratory infection. *BMJ* 1993; 306: 612 – 5

14. Zwi K, Pettifor J, Soderlund N et al. HIV infection and in- hospital mortality at an academic hospital in South Africa. *Arch Dis Child* 2000 ; 83:227-230

15. Danker W.M, Lindsey C.J, Levin J.M et al Correlate of opportunistic infection in children infected with HIV managed before HAART. *Paediatr Infects Dis J 2001*; 20(1): 40 – 48.

16. Graham S.M, Mtitimila E.L, Molyneux M.E et al Clinical presentation and outcome of pneumocystis *jerovecii* pneumonia in Malawian Children. *Lancet* 2000; 355: 369 – 373

17. Sheikh S, Madiraju K, Rao M et al Bronchiectasis in pediatric AIDS *Chest* .1997; 112(5): 1202 – 1207

18. Cristina M.C, Nascimento C. Benguigui Y et al. Childhood pneumonia; clinical aspects associated with hospitalization and death. *Braz J Infect Dis* 2002; 6(1): 22 – 28

19. Campbell H, Byass P, Lyold-Evans N et al. Assessment of clinical criteria for identification of severe acute lower respiratory infection in children. *Lancet* 1989; 353:297-9

20. Shann F Bacterial pneumonia; commoner than perceived. *Lancet* 2001; 357: 2070 – 72

21. Berkley J.A, Mwangi I, English M et al Use of clinical syndromes to target antibiotic prescribing in seriously ill children in malaria endemic area. *BMJ* 2005; 330: 995.

22. Madhi S.A et al Increased disease burden and antibiotic resistance of bacteria causing severe community acquired lower respiratory tract infections in HIV- infected children. *Clin Infect Dis* 2000; 31(1): 170 – 176.

23. Berkley J.A, Bauni E, Scott A.G et al. Bacteremia among children admitted to a rural hospital in Kenya. *The New Eng J .Med* 2005; 352:39 – 47

24. Benbachir M et al Two years surveillance of antibiotic resistance in strep pneumonia in four African countries.*Abstract E -17:172 Proceedings, 38th ICAAC 1998.*

25. Naeem Noorani Bacterial isolates in severely malnourished children at Kenyatta Hospital. M.*med Paediatric Dissertation 2004*

26. Health research methodology: a guide to training on research methods. Second edition WHO page 76.

27. Usen S, Weber M, Adegbola R. et al. Clinical predictors of hypoxemia in Gambia children with lower respiratory tract Infection.
BMJ 1999; 318: 89-91

28. Dyke T, Lewis D, Rudeen K et al. Predicting hypoxia in children with Acute Lower Respiratory Infection (ALRI) J. *Trop Pediatr* 1995; 41: 196-207

29. Wagner G.E in microbiology, 2nd edition, kingsbury d.t, wagner G.E (Eds), William and wilkins, baltimore publishers 1990; 319.

30. Shann F, Hart K, Thomas D. Acute lower respiratory infections in children: Possible criteria for selection of patients for antibiotic therapy and hospital admission. *Bull WHO* 1984; 62: 749-53

31. Pio .A, Loweski .J et al. The magnitude of the problem of acute respiratory infections. International workshop on Acute Respiratory Infection in children, Sydney, 1984.

32. Alavi M. Clinical predictors of hypoxemia in children admitted with pneumonia at KNH. 1996; M.*Med Paediatric Dissertation.*

31. Kose J. Prevalence of PCP in HIV infected children admitted with severe pneumonia at KNH. 2004;M.*Med Paediatric Dissertation.*.

32. Zar H J, Hanslo D, Klein M et al Etiology and outcome of pneumonia in HIV infected children hospitalized in South Africa. A*cta Paediatr* 2001; 90: 119-25.

33. Kamiya Y, Mtitimila E ,Graham S.M et al Pneumocystis *jerovecii* pneumonia in Malawian children. *Ann. Trop Paediatr* 1997; 17(2): 121-6

34. Dechaboon A, Haslo D, Apolles P et al. Pneumocystis carinii in South African children infected with HIV. *Pediatr Infect Dis J.* 2000; 19 (7): 603-7

35. Weber M W and Muholland E.K. Pulse oximeter in developing countries (letter). *Lancet* 1998; 351: 1589.

36. Torre Bouscoulet L. et al. Precision and accuracy of a 'pocket' pulse oximeter in Mexico City *Rev Invest Clin.* 2006; 58(1): 28-33.

37. Suwanjutha S. Risk factors associated with morbidity and mortality of pneumonia in Thai children under 5 years. *Journal .Trop.Med Public Health* 1994; 25(1): 60-6

APPENDIX 1

WHO guidelines on classification of pneumonia

Signs & symptoms	Classification	Treatment
- Central cyanosis - Severe respiratory - distress e.g. head nodding - Not able to drink	Very severe pneumonia	- Admit - Appropriate antibiotics - Manage airway - Oxygen - Treat high fever
- Chest in drawing	Severe pneumonia	- Admit - Appropriate antibiotics - Oxygen -Treat high fever.
Fast breathing -60b/min <2/12 -50b/min 2- 11/12 -40b/min 1- 5 yrs Definite crackles on auscultation	Pneumonia	- Home care - Oral amoxyl - Advise when to return for follow up. (after two days)
No signs of either severe or very severe pneumonia	No pneumonia Cough/cold	-Home care -Soothe throat with lozenges -Give safe cough remedy -Continue feeds.

APPENDIX II

Social Demographic data

Date____/_____/_____ ID NO _____

1) Name_____
2) Residence_____
3) Informant_____(Relation to the child)
4) Date o Birth_____/_____/_____/
5) Age in months_____
6) Sex
1= Male, 2=Female ☐
7) Birth weight_____(gms), Gestation_____(weeks)
8) Mother's education Status
1=Uneducated, 2=Primary, 3= Secondary, 4=Tertiary ☐
9) Mother's age in yrs_____

Medical History

9) Any known chronic underlying illnesses

1=Yes, 0=No ☐ Specify_____.

10) History of confirmed measles disease , yes=1,no=0 if yes how long ago?--weeks

11) History of visiting other health facility due to current illness
1=Yes, 2=No ☐

12) Referral from another health facility
1=Yes, 2=No ☐

Symptoms
1= Present, 0= Absent

Symptom		Duration (in days)
Cough	☐	_____
Difficulty in breathing	☐	_____
Fever	☐	_____
Convulsions	☐	_____
Vomiting everything	☐	_____
Abnormally sleepy	☐	_____

Physical Examination

Weight _____ (kgs), height / length _____ (cms), Temp _____ (^{0}C)

LUMAC_____ (Cms), R.R _____(breaths/min), H.R_____(beats/min)

Oxygen saturation_____ %

Signs

1= Present, 0= Absent

1) Cyanosis ☐

2) Grunting. ☐

3) Audible wheeze ☐

4) Severe respiratory distress (e.g. head nodding) ☐

5) Lower chest in drawing. ☐

6) Inability to breastfeed or drink ☐

7) Severe dehydration ☐

8) Severe pal mar pallor ☐

9) Visible severe wasting ☐

10) Oedema of malnutrition ☐

11) Hepatomegally ☐

12) Splenomegally. ☐

13) Gallop rhythm ☐

14) AVPU scale

1=A, 2=V, 3= P, 4= U ☐

15) Severity of pneumonia ☐

3=very severe pneumonia

2=severe pneumonia

1=pneumonia (Non severe)

Evolution

1) Outcome of admission

1= Dead, 0= Alive ☐

2) Duration of Hospital stay_____ (Days)

Initial Antibiotic Therapy (at PFC)

Names of Drugs	Dose (mgs)	Frequency
1) X-pen		
2) Gentamycin		
3) Chloramphenicol		

Initial Antibiotic Therapy (On admission in the wards)

Names of Drugs	Dose (mgs)	Frequency
1) X-pen		
2) Gentamycin		
3) Chloramphenicol		

2nd Line antibiotics Date started_____/_____/_____

Names of drugs	Dose (mgs)	Frequency
_____	_____	
_____	_____	

Oxygen prescribed 1 = Yes 2 = No

Flow rate-_____L/min

Mode of oxygen delivery

1= Nasal Prongs

2= Nasal Catheter

3=Face Mask without reservoir

4= Others. Specify_____

Laboratory Data

1) Blood culture
1= positive, 0= Negative ☐

Culture species	Drug sensitivity Resistant antibiotic	sensitive antibiotic
_____		
_____	_____	_____
	_____	_____
_____	_____	_____

3) CSF Culture ☐
1= positive, 0= Negative

Culture species	Drug sensitivity Resistant antibiotic	sensitive antibiotic
_____		
_____	_____	_____
	_____	_____
	_____	_____

4) HIV ELISA (Age above 18 months) ☐
1=positive, 0= negative

5) PCR (Age below 18 months) ☐
1=positive, 0= negative

APPENDIX III

Table 26 ***WHO/NCHS normalized reference weight-for-length (49-84 cm) and weight-for-height (85-110 cm), by sex***

Boys' weight (kg)						Girls' weight (kg)				
-4SD	**-3SD**	**-2SD**	**-1SD**	**Median**	**Length**	**Median**	**-1SD**	**-2SD**	**-3SD**	**-4SD**
60%	**70%**	**80%**	**90%**		**(cm)**		**90%**	**80%**	**70%**	**60%**
1.8	2.1	2.5	2.8	3.1	49	3.3	2.9	2.6	2.2	1.8
1.8	2.2	2.5	2.9	3.3	50	3.4	3	2.6	2.3	1.9
1.8	2.2	2.6	3.1	3.5	51	3.5	3.1	2.7	2.3	1.9
1.9	2.3	2.8	3.2	3.7	52	3.7	3.3	2.8	2.4	2
1.9	2.4	2.9	3.4	3.9	53	3.9	3.4	3	2.5	2.1
2	2.6	3.1	3.6	4.1	54	4.1	3.6	3.1	2.7	2.2
2.2	2.7	3.3	3.8	4.3	55	4.3	3.8	3.3	2.8	2.3
2.3	2.9	3.5	4	4.6	56	4.5	4	3.5	3	2.4
2.5	3.1	3.7	4.3	4.8	57	4.8	4.2	3.7	3.1	2.6
2.7	3.3	3.9	4.5	5.1	58	5	4.4	3.9	3.3	2.7
2.9	3.5	4.1	4.8	5.4	59	5.3	4.7	4.1	3.5	2.9
3.1	3.7	4.4	5	5.7	60	5.5	4.9	4.3	3.7	3.1
3.3	4	4.6	5.3	5.9	61	5.8	5.2	4.6	3.9	3.3
3.5	4.2	4.9	5.6	6.2	62	6.1	5.4	4.8	4.1	3.5
3.8	4.5	5.2	5.8	6.5	63	6.4	5.7	5	4.4	3.7
4	4.7	5.4	6.1	6.8	64	6.7	6	5.3	4.6	3.9
4.3	5	5.7	6.4	7.1	65	7	6.3	5.5	4.8	4.1
4.5	5.3	6	6.7	7.4	66	7.3	6.5	5.8	5.1	4.3
4.8	5.5	6.2	7	7.7	67	7.5	6.8	6	5.3	4.5
5.1	5.8	6.5	7.3	8	68	7.8	7.1	6.3	5.5	4.8
5.3	6	6.8	7.5	8.3	69	8.1	7.3	6.5	5.8	5
5.5	6.3	7	7.8	8.5	70	8.4	7.6	6.8	6	5.2
5.8	6.5	7.3	8.1	8.8	71	8.6	7.8	7	6.2	5.4
6	6.8	7.5	8.3	9.1	72	8.9	8.1	7.2	6.4	5.6
6.2	7	7.8	8.6	9.3	73	9.1	8.3	7.5	6.6	5.8
6.4	7.2	8	8.8	9.6	74	9.4	8.5	7.7	6.8	6
6.6	7.4	8.2	9	9.8	75	9.6	8.7	7.9	7	6.2
6.8	7.6	8.4	9.2	10	76	9.8	8.9	8.1	7.2	6.4
7	7.8	8.6	9.4	10.3	77	10	9.1	8.3	7.4	6.6

7.1	8	8.8	9.7	10.5	78	10.2	9.3	8.5	7.6	6.7
7.3	8.2	9	9.9	10.7	79	10.4	9.5	8.7	7.8	6.9
7.5	8.3	9.2	10.1	10.9	80	10.6	9.7	8.8	8	7.1
7.6	8.5	9.4	10.2	11.1	81	10.8	9.9	9	8.1	7.2
7.8	8.7	9.6	10.4	11.3	82	11	10.1	9.2	8.3	7.4
7.9	8.8	9.7	10.6	11.5	83	11.2	10.3	9.4	8.5	7.6
8.1	9	9.9	10.8	11.7	84	11.4	10.5	9.6	8.7	7.7
7.8	8.9	9.9	11	12.1	85	11.8	10.8	9.7	8.6	7.6
7.9	9	10.1	11.2	12.3	86	12	11	9.9	8.8	7.7
8.1	9.2	10.3	11.5	12.6	87	12.3	11.2	10.1	9	7.9
8.3	9.4	10.5	11.7	12.8	88	12.5	11.4	10.3	9.2	8.1
8.4	9.6	10.7	11.9	13	89	12.7	11.6	10.5	9.3	8.2
8.6	9.8	10.9	12.1	13.3	90	12.9	11.8	10.7	9.5	8.4
8.8	9.9	11.1	12.3	13.5	91	13.2	12	10.8	9.7	8.5
8.9	10.1	11.3	12.5	13.7	92	13.4	12.2	11	9.9	8.7
9.1	10.3	11.5	12.8	14	93	13.6	12.4	11.2	10	8.8
9.2	10.5	11.7	13	14.2	94	13.9	12.6	11.4	10.2	9
9.4	10.7	11.9	13.2	14.5	95	14.1	12.9	11.6	10.4	9.1
9.6	10.9	12.1	13.4	14.7	96	14.3	13.1	11.8	10.6	9.3
9.7	11	12.4	13.7	15	97	14.6	13.3	12	10.7	9.5
9.9	11.2	12.6	13.9	15.2	98	14.9	13.5	12.2	10.9	9.6
10.1	11.4	12.8	14.1	15.5	99	15.1	13.8	12.4	11.1	9.8
10.3	11.6	13	14.4	15.7	100	15.4	14	12.7	11.3	9.9
10.4	11.8	13.2	14.6	16	101	15.6	14.3	12.9	11.5	10.1
10.6	12	13.4	14.9	16.3	102	15.9	14.5	13.1	11.7	10.3
10.8	12.2	13.7	15.1	16.6	103	16.2	14.7	13.3	11.9	10.5
11	12.4	13.9	15.4	16.9	104	16.5	15	13.5	12.1	10.6
11.2	12.7	14.2	15.6	17.1	105	16.7	15.3	13.8	12.3	10.8
11.4	12.9	14.4	15.9	17.4	106	17	15.5	14	12.5	11
11.6	13.1	14.7	16.2	17.7	107	17.3	15.8	14.3	12.7	11.2
11.8	13.4	14.9	16.5	18	108	17.6	16.1	14.5	13	11.4
12	13.6	15.2	16.8	18.3	109	17.9	16.4	14.8	13.2	11.6
12.2	13.8	15.4	17.1	18.7	110	18.2	16.6	15	13.4	11.9

CONSENT FORM

Investigator's statement.

Investigator: Beth Maina. Position: post graduate student, dept of paediatrics, University of Nairobi.

We are asking you to volunteer for a research study; we would like to explain the purpose of the study including the risks and benefits and what would be expected of you if you agree to be in the study. It's important that you understand that your participation is voluntary. This form will help you decide if you want to take part in the study. If you choose to be part of the study, we will ask you to sign your name and make your match in your form. We will give you a copy to keep. This process is called informed consent.

Introduction.

Pneumonia is a common disease affecting many children in Kenya. It's a treatable acute illness whose outcome is influenced by various factors. The purpose of this document is to explain to you the aim of this study, what it entails, its benefits to your child and others like him, and the part your child will play in the study. Please read through this document, you will then have time to ask any questions and seek any clarifications. Having then understood what the study is about, I will then ask your consent for your child to participate in the study.

The study.

OUTCOME OF PNEUMONIA IN CHILDREN ADMITTED AT KNH is a study which attempts to describe the spectrum of children with pneumonia who get admitted at KNH based on the severity of their illness as well as determining some risk factors influencing their progress while in the ward. The study includes children aged between 2 months to 5 years diagnosed to have pneumonia who need inpatient care. This will be based on your child's symptoms and signs. You will be asked some questions by the research assistant regarding where you live, the child's illness and treatment taken for this problem prior to coming to KNH. I, as the principal researcher will document subsequent management and progress of your child at KNH's paediatric wards. This information will be entered in forms and subsequently stored in a computer.

Procedures.

In this study specimen of blood will be taken for culture and HIV testing, both will require 1ml of blood each. HIV screening will be done after pre test counselling as it can increase severity of pneumonia. After results come out, you will be informed of the results following a post test counselling. CSF culture will be performed in case the child is suspected to have meningitis via inserting a special needle in the lower back in the 4^{th} and 5^{th} lumbar interspaces. About 0.5ml of CSF will be obtained. These investigations form part of the workup for children with pneumonia admitted to the wards. The results will be availed to your child's doctor promptly so as to assist in subsequent management of your child while in the ward .There will therefore be no duplication on the tests performed on your child. Utmost care will be taken to ensure that your child is not harmed in any way.

Benefits/Risks for your child.

From this study your child, along with others with the same disease will benefit from our improved understanding on the nature of their illness which will help in optimizing their care.

There are a few major adverse effects associated with afore mentioned procedures. However, the risk that the confidentiality of his medical records will be breached will be controlled by having no name attached to the information gathered from you.

The child's rights.

Participation in this study is voluntary and you are under no obligation to give consent for your child to take part in the study. Refusal to give consent will in no way affect the standard management of your child's illness. You have a right to understand what the study is about, the risks your child will be exposed to and any benefits the study will have on him. You have a right to confidentiality of the information gathered from you. These rights will be ensured in this study. My 24hour contact is DR B. MAINA, 0722639305 in case of any urgent difficult. I can also be reached through the University of Nairobi, Department of Paediatrics. You can also get in touch with the chairperson of the ethics and research committee of KNH, Prof Bhatt on tel no.726300-9 or P.O Box 20723 Nairobi in case of any ethics question.

Consent.

I_____ parent/guardian

to_____, having been explained to

about this study, by _____, give

consent for my child to participate. My rights have been explained

to me and assured. Signed

_____.

Date_____/_____/_____.