

TITLE

MEASLES REVISITED: ACROSS-SECTIONAL  
DESCRIPTIVE STUDY OF FACTORS ASSOCIATED WITH  
CLINICALLY DIAGNOSED MEASLES INFECTION IN  
CHILDREN ADMITTED TO KENYATTA NATIONAL  
HOSPITAL.

BY

MEDICAL LIBRARY  
UNIVERSITY OF NAIROBI

DR MURUTHI P. N.

University of NAIROBI Library



0324837 4

USE IN THE LIBRARY ONLY

**A THESIS SUBMITTED IN PART FULFILLMENT FOR THE  
DEGREE OF MASTERS IN MEDICINE  
(PAEDIATRICS) AT THE UNIVERSITY OF NAIROBI**

MEDICAL LIBRARY  
UNIVERSITY OF NAIROBI

**AUGUST 2003.**

**DECLARATION**

I declare that this paper is my original work and has not been submitted for a degree in any other university.

SIGNED: .....  .....

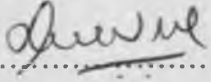
DR. MURUTHI PATRICIA, MB.CH.B (NAIROBI)

This thesis has been submitted for the examination with our approval as University Supervisors.

SUPERVISORS: 1. DR. E. OBIMBO MBCHB, MMED (PAED)  
LECTURER  
DEPARTMENT OF PAEDIATRICS  
UNIVERSITY OF NAIROBI

Signature: .....  .....

2. DR. F. WERE, MBCHB, MMED (PAED)  
SENIOR LECTURER, NEONATOLOGIST  
DEPARTMENT OF PAEDIATRICS  
UNIVERSITY OF NAIROBI.

Signature: .....  .....

# LIST OF CONTENTS

Item	
Title.....	1
Declaration.....	3
List of contents.....	4
Dedication .....	5
Acknowledgement.....	6
List of abbreviations.....	7
Definitions.....	8
Abstract.....	10
Introduction and literature review.....	12
Justification and significance.....	18
Study materials and methods.....	19
Results.....	24
Discussion.....	33
Conclusion and recommendations.....	43
Appendix I.....	44
Appendix II.....	46
References.....	53

## **DEDICATION**

This study is dedicated to my mother Joyce Muruthi for her care, prayers, encouragement and the foundation she laid in me.

## **ACKNOWLEDGEMENT**

I want to thank all the people who assisted me in any way with the initiation and completion of this study.

I acknowledge with deep appreciation the step by step guidance, useful suggestions and reference materials that my supervisors (Dr E. Obimbo and Dr. F. Were) tirelessly and graciously provided from the beginning to the completion of the study.

## **Abbreviations**

CDC	Centre for disease Control
EPI	Expanded Programme of Immunization
EZ	Edmonston Zagreb
GOK	Government of Kenya
HIV	Human Immunodeficiency Virus
IgM	Immunoglobulin M
KEPI	Kenya Expanded Programme of Immunization
KDHS	Kenya Demographic Health Survey
KNH	Kenyatta National Hospital
LTB	Laryngotracheobronchitis
US	United States
WHO	World Health Organization

## Definitions

Missed opportunity to immunize occurs: when,

- The health facility does not offer immunization services.
- The health workers do not use appropriate contra-indications to immunization
- The health workers do not routinely screen children for their immunization status and offer recommended vaccines.
- The health worker does not give all the antigens for which a child is eligible.

## Measles immunization recommendations

- Measles immunization is given to babies who are 9 months or above irrespective of whether they suffered from measles or measles like illness.
- Measles immunization should be given to babies 6 months and above in the following circumstances.
  - Sibling to a child with measles illness.
  - Children living in crowded places, refugee camps and children homes.
  - Children age 6-9 months admitted to hospital for any condition.
  - Children in a locality experiencing with measles epidemic.

WHO clinical case definition for measles is any person with; generalized maculopapular rash (i.e. Non vesicular) and history of fever 38 °C. or more (if not measured hot to touch) and at least one of the following; cough, corhyza or conjunctivitis (i.e. red eyes), or any person in whom a health professional suspects measles.



Other clinical case and laboratory definitions includes the CDC clinical case definition for measles outlined in 1990 and revised in 1996 which is any person with an illness characterized by; generalized rash lasting greater than or equal to 3 days, a temperature greater than or equal to 38.3 °C, cough, corhyza or conjunctivitis.

The laboratory criteria for diagnosis are; isolation of measles virus from clinical specimen or positive serologic test for measles IgM or significant rise in measles antibody level by any standard serologic assay. The CDC case classification is suspect in any febrile illness accompanied by rash, probable in a case that meets the clinical case definition and has non-contributory serologic or virologic testing and is not epidemiologically linked to a onfirmed case. A laboratory confirmed case does not need to meet the clinical case definition.

Failed measles immunization occurs when an immunized child contracts the disease in a severe form.

## **ABSTRACT**

Measles incidence has been reported to be significantly high with outbreaks being reported in several Kenyan districts despite continued measles immunization. Measles vaccine failure remains a significant problem. Measles cases in the under 9 months old children are frequently being reported. Factors that may be contributing to the persistent occurrence of high numbers of measles cases require evaluation to enable control and planned eradication of the disease.

A cross-sectional descriptive study was carried out from January to July 2002 to determine the prevalence of measles vaccine failure, unimmunized under 9 months old, missed measles immunization opportunities and malnutrition states among children presenting to KNH with acute measles.

A total of 92 children with measles were evaluated. The key informants were the parents or guardians and available hospital records.

The results were as follows:

Regarding immunization status, 61/92 (66%) had not been vaccinated against measles, 29/92 (32%) had received measles vaccine regarded as vaccine failure and immunization status was unknown for 2 (2%) of the children. Among the 61 unimmunized children, 30(49%) were under 9 months old while 27(44%) were 9 months or older constituting missed measles immunization opportunities. The missed immunization opportunities included 13 children

with nosocomial measles and 14 cases who had their measles immunization deferred by health workers. Malnutrition was prevalent among children with measles, 48(52%).

We conclude that contraction of measles before the age of 9 months, measles vaccine failure and missed measles immunization opportunities were frequent contributing factors to occurrence of measles in children hospitalized at KNH with acute measles.

There is need for consideration of introduction of immunization facilities in PFC, establishment of infectious disease isolation units to limit nosocomial measles, continued education of health workers and further research to evaluate causes of vaccine failure.

## **INTRODUCTION.**

Measles is an acute highly infectious communicable disease, caused by an RNA virus of the family paramyxoviridae, genus morbilivirus. The disease is characterized by three stages: an incubation stage of approximately 10-12 days with few if any signs or symptoms; a prodromal stage with an enanthem (Koplik spots) on the buccal and pharyngeal mucosa, slight to moderate fever, mild conjunctivitis, corryza and an increasingly severe cough; and a final stage with maculopapular rash erupting successively over the neck and face, body, arms and legs and accompanied by high fever<sup>1</sup>.

Measles is a severe disease causing high morbidity and mortality. According to some estimates, the measles virus may be responsible for more child death than any other single pathogen mainly through its complications like pneumonia, diarrhoea and malnutrition<sup>2</sup>. The disease often exerts delayed effects on the child's health due to lowered immunity, malnutrition, and hypovitaminosis A. Measles can lead to life long disabilities including brain damage, blindness and deafness especially in deprived urban areas where overcrowding, poor sanitation and pockets of low immunization ensure the continued circulation of measles and other diseases.

Before the measles vaccine became available, virtually all children contracted measles with an estimated 130 million cases and around 7.8 million deaths globally each year<sup>3,4</sup>. In one study approximately 15.5% of deaths of African children under 5 years of age were attributed to measles<sup>5</sup>. In Kenya case fatalities of as high as 10% have been reported<sup>6,7</sup>.

In 1954 a live attenuated measles vaccine was developed that was highly immunogenic and protective against measles <sup>8,9</sup>. By 1963 a better safer form of the vaccine had been developed which showed seroconversion rates between 86% and 95% in children over 9 months <sup>10,11</sup>. In Nairobi, children given this vaccine between the ages of 6-9 months showed seroconversion rates of 92% <sup>12</sup>.

In 1977 measles vaccine was incorporated into EPI resulting in increased immunization coverage, reduction in measles prevalence from 130 million cases yearly to 30 million cases in 2001 and decreased mortality from 6% to 2.8% by 2001 <sup>13,14</sup>. Ninety-eight percent of these deaths occur in developing countries and half of these deaths occur in children under five years of age <sup>2</sup>

The WHO, PAHO and CDC recommended adoption of the goal for global eradication with a time target between 2005-2010 <sup>15</sup>. Measles outbreak should be treated as an opportunity to reinforce surveillance, assess the health burden of continuing measles transmission and identifying appropriate measures to prevent future outbreaks.

In June 1980 when Kenya launched KEPI, measles vaccination became available free of charge to Kenyan children and national measles immunization coverage of children under 1 year rose from below 30% in the seventies to 60% in 1987, 71% in 1989 and 79% in 1998 <sup>16,17,18,19,20</sup>.

The optimum age of measles immunization has changed over the years in response to various findings on seroconversion rates, resistance of maternal antibodies and age specific

incidences of measles. It was earlier recommended at a symposium on measles that since the disease was more common in younger children vaccination be started at 6 months age <sup>21</sup>. However based on a joint Government/WHO collaborative study in Kenya, (1975) which found that 90% of the children no longer had maternal antibodies at 7-8 months of age and that almost all the children showed seroconversion at 7.5 months, the WHO recommended that the optimum age of immunization in endemic areas be 9 months of age <sup>22</sup>. The optimum age of immunization was also estimated based on the Machakos study in Kenya which showed that the proportion of cases that would be prevented by immunizing at 8,9 and 10 months would be 79%, 84% and 82% respectively <sup>23</sup>. Usually the lower age limit for measles supplemental immunization activities should be 9 months <sup>24</sup>.

Measles in United States occurs most often in unimmunized pre-school aged children, in teenagers and young adults who have been immunized<sup>1</sup>. The world summit for children in 1990 set a goal of vaccinating 90% of world's children against measles by the year 2000.<sup>25</sup> WHO has embarked on measles elimination initiative that comprises a three part vaccination strategy (catch up, keep up and follow up) and enhanced surveillance. Catch up involves mass supplemental vaccination campaigns of all children aged nine months through 14 years without regard to previous history of measles disease or vaccination. Keep up involves strengthening existing routine measles immunization and follow up involves mass supplemental vaccination targeting all children born since the previous catch up campaign.

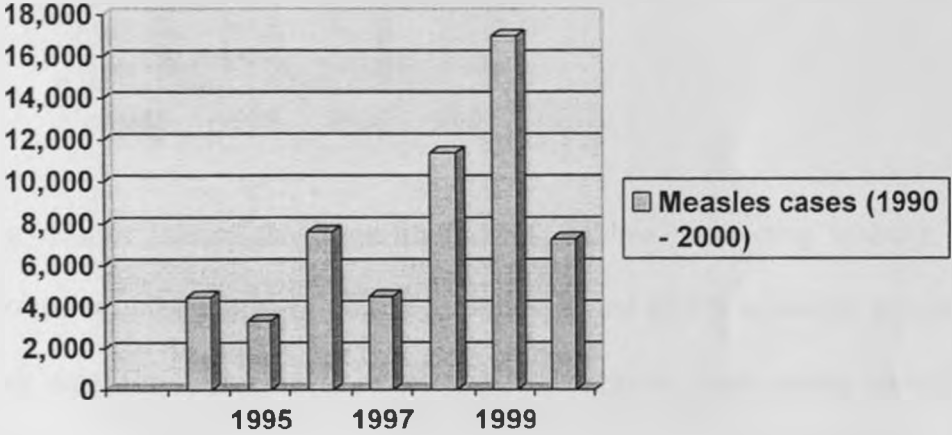
<sup>26,27,28</sup>

Currently KEPI is putting into place a five-year action plan towards achieving the world summit for children goal by the year 2005. The first catch up campaign was done in 2002 and children aged 9 months to 14 years were targeted for measles immunization and vitamin A supplementation. KEPI is also planning to strengthen routine primary vaccination services to ensure keep up immunization of each birth cohort of every subsequent year. A follow-up campaign is planned for late 2004 and early 2005 targeting children aged 9 to 59 months for measles immunization and vitamin A supplementation <sup>29</sup>.

Local studies by Sonoyia and REACH observed 0.29% and 0.5% missed measles immunization opportunities respectively in the general population, which was very low <sup>30,31</sup>. Wainaina reported missed immunization opportunities of 57.5% among inpatients and 100% in the outpatients at KNH of the immunizable diseases as recommended by KEPI<sup>32</sup>. Review of missed opportunity studies identified most important reasons for missing opportunities as; failure to administer all vaccines for which a child is eligible when they come in late, false contraindications, reluctance of health workers to open multivial dose for few persons to avoid vaccine wastage and logistical problems such as vaccine shortage, poor clinic organization and inefficient clinic scheduling <sup>33</sup>. Others include: mothers too busy to wait, uninformed or alienated, health workers acceptance of verbal history of earlier measles infection and failure to immunize an eligible child because of lack of immunization card. A history of measles disease is not sufficient reason to defer immunization since physicians, health care workers, mothers and other caretakers occasionally mistake other fever and rash illnesses for measles.

With an effective immunization program in place, it would be expected that the incidence and prevalence of measles should continue to fall. However there were significant numbers reported with outbreaks in several districts in 1998,1999 and 2000<sup>29</sup> as shown in Figure I.

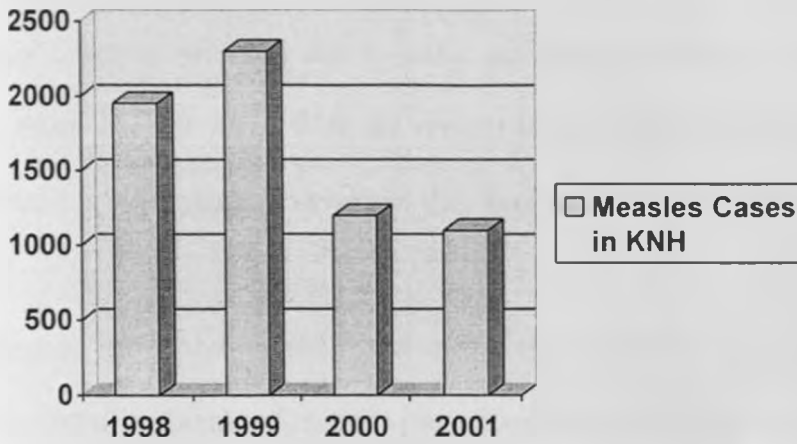
**Figure I: 1998 EPI TARGET DISEASE, REPORTED MEASLES CASES 1990-2000.**



Over the past years anecdotal observations at various hospitals in Nairobi have shown significant numbers of measles cases with similar reports in Kenyatta National Hospital as shown in figure II. This includes both inpatients and outpatients, which is a relatively accurate report from the statistics department.



**Figure II: Reported Measles Cases in KNH statistics Department.**



The reasons behind the large number of children contracting measles are not known. Measles vaccine failure of 38.3% countrywide and 82.1% in central province was reported from analysis of reported measles cases <sup>29</sup>. Measles cases among unimmunized under 9 months population are also being reported but the magnitude is not known.

Scheifele and Forbes showed that there was prolonged excretion of giant cells in children suffering from measles and malnutrition suggesting that there was a prolonged infection in these children <sup>34</sup>. Dosetor and others showed persistence of measles virus in lymphocytes of malnourished children, and that these children had depressed cell-mediated immunity <sup>35</sup>. Mononuclear cells of malnourished children are more susceptible to measles virus than of normal children hence higher measles attack rates in malnourished children.

## **Justification and significance**

Measles, a disease easily preventable by vaccination still causes a considerable burden in many countries primarily due to under utilization of measles vaccine despite its availability for more than 40 years. With the reports of significant numbers of measles cases in recent years, it is necessary to re-evaluate this disease if total eradication is to be achieved.

Effective identification and isolation of cases and mass vaccination of susceptible persons will control outbreaks of measles preventing major cost incurred, morbidity, and mortality by the disease.

Some of the unanswered questions include the profile of measles cases in terms of ages of the patients, immunization status, immunization failure, missed immunization opportunity and nutritional status. The age groups included in mass supplemental immunization in our set up are based on information based on data obtained in developed countries. We need to determine age groups to include in mass campaigns in view of the Epidemiology of measles in our set up. Also with increasing poverty in the general population, cost sharing in health care system and support of KEPI activities by the government the above should be determined.

Such information could help elucidate the contribution of vaccine failure, inappropriate schedule and missed opportunities for measles vaccination to occurrence of measles and reasons for under-utilization of the immunization facilities.

## **Main objective**

To describe the factors associated with measles infection among children admitted to the paediatric wards and paediatric filter clinic of KNH.

## **Specific objectives.**

1. To determine the prevalence of measles vaccine failure among measles cases presenting to KNH.
2. To determine the prevalence of under 9 months old unimmunized children among measles cases presenting to KNH.
3. To determine the prevalence of missed measles immunization opportunities among children presenting with measles to KNH.
4. To determine the role of malnutrition in children presenting with measles to KNH.

## **Study materials and methods**

### **Study design**

A cross sectional descriptive study was carried out in KNH to describe the occurrence of failed measles immunization, under 9 months children contracting measles, missed measles immunization opportunities and malnutrition among children treated with acute measles infection.

**Study area.**

The study was carried out at KNH, the national public referral hospital and the teaching hospital for the University of Nairobi, which also serves as a provincial hospital for the residents of Nairobi and its environs. There are four general paediatric wards and paediatric filter clinic, which serves as the paediatric emergency unit.

**Study period:**

The study was carried out from January 2002 to July 2002

**Study population.**

The study population consisted of children who were 12 years and below fulfilling WHO clinical case definition for measles.

**Sample size**<sup>36</sup>

$$N = \frac{z (1-\alpha/2)^2 P (1-p)}{d^2}$$

$z (1-\alpha/2) = 1.96$  (Standard normal deviate)

$\alpha = 0.05$

$p = 0.38$  estimated population of immunized children who develop measles<sup>33</sup>

$d = 0.1$  (degree of accuracy)

$n = 91$

## **Patient selection**

A retrospective pilot study was carried out to determine the trend of measles prevalence in KNH. The investigator visited the hospital records department accessing records for measles cases for the years 1998, 1999, 2000 and 2001. The prevalence was noted to have been significantly high throughout this period, with more than 1000 cases of severe measles hospitalized annually.

The investigator visited the general paediatric wards and the paediatric outpatient unit at KNH and identified the measles cases diagnosed by the primary doctors. The rationale and benefits of the study were explained to the caretaker and consent was obtained. The WHO clinical case definition for measles, as recommended by the Ministry of Health for the diagnosis of measles was used in the identification of the cases. Those who were identified by the primary doctor and didn't satisfy the WHO definition requirement were disqualified from the study. Using primary doctors' notes, history and physical examination; eligible children were identified and consent for participation sought. Almost all the children enrolled in the study had all the symptoms of rash, fever, cough, coryza and conjunctivitis. Birth history was obtained from caretaker in an attempt to describe maturity at birth. History of previous visit to health facility or admission to hospital wards was obtained. Possible contact with measles cases in hospital environment was also sought in order to identify those who had nosocomial measles. Information on any other possible contact with measles cases was obtained identifying the locality of contact and relationships with contact cases.

Immunization status was evaluated in terms of whether given or not by the time of disease by interviewing the caretaker and verification from clinic card where available. Reasons for non-immunization in the children eligible for immunization were obtained from the caretaker. Missed measles immunization opportunity among the study cases was calculated from the number of children with invalid contraindications to immunization (mild febrile illness and previous history of measles infection) and those who completed a hospital visit, were eligible for immunization and never got immunized.

Age was computed from the reported date of birth by the caretaker or from hospital records. The children were weighed using the weighing balance in the various paediatric wards and PFC. None of the children was dehydrated at the time of weighing. Z scores were obtained for weight/age, height/age and weight/height using anthropometric software package (CDC/WHO 1990). Indicators for malnutrition were derived as scores below 2SD of any of the parameters. The computed indices were used as indicators of under-weight, stunting or wasting. The inpatient children who enrolled in the study were then visited daily noting their progressive recovery, complications and outcome. The duration of hospital stay was calculated from day of admission and date of discharge. All the data obtained was filled in the study questionnaire.

### **Study limitations.**

Most of the information obtained was ascertained verbally thus with a possibility of error in exposure measurement. The diagnosis of measles was made from history and by physical

examination and though acceptable by WHO, it may have included other rash illnesses with fever.

#### **Data management.**

Data entry and analysis was done using Statistical Package for Social Sciences package. Verification of information and cleaning of the data was done before analysis. Prevalence rates of measles vaccine failure, unimmunized under 9 months old, missed measles immunization opportunities and malnutrition states among the measles cases were obtained. Anthropometric software package was used to analyze the anthropometric data. Results were presented in tables, graphs and pie charts.

#### **Ethical consideration.**

Approval to carry out the study was obtained from the KNH ethical committee. Informed consent was obtained from caretakers. The examination and measurements done during the study were noninvasive. All the information obtained was treated with maximum confidentiality.

## RESULTS

### Socio-demographic characteristics

A total of 92 children were available for analysis, 90 from the wards and 2 from outpatient department. Their sociodemographic parameters are summarized in table I.

Table 1: Sociodemographic characteristics of the children.

Characteristic	Number	Percent (%)
Geographical residence		
▪ Eastlands	34	37
▪ Southlands	27	29
▪ Westlands	8	9
▪ Central	5	5
▪ Outside Nairobi	18	20
Sex		
▪ Male	53	58
▪ Female	39	42
Maturity at birth		
▪ Preterm	3	3
▪ Term	88	96
▪ Unknown	1	1
Birth weight		
▪ < 2.5kg	4	4
▪ >2.5kg	82	89
▪ Unknown	6	7
*Age measles vaccination was given		
▪ < 9	1	3
▪ ≥ 9	28	97

\* n=29 (number of vaccinated children in the study)

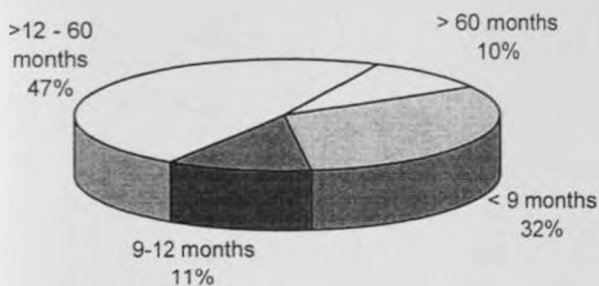


Out of the 92 study cases, 53(58%) were males and 39 (42%) were females. Most of the children, 88 (96%) had been born at term gestation and only 4 (4%) weighed < 2.5kg.

### Age Distribution

Figure III summaries the age distribution of the children seen.

**Figure III: Age Distribution**



The median age was fourteen months and ranged from three months to eleven years. Thirty of the ninety-two children(32%) developed measles before the age of nine months. About 11% were aged 9-12 months, 47% aged 12-60 months, while 10% were older than 60 months.

## Nutritional status

Nutritional status of the study cases is presented in table 2.

**Table 2: The various nutritional status of the study cases n=92.**

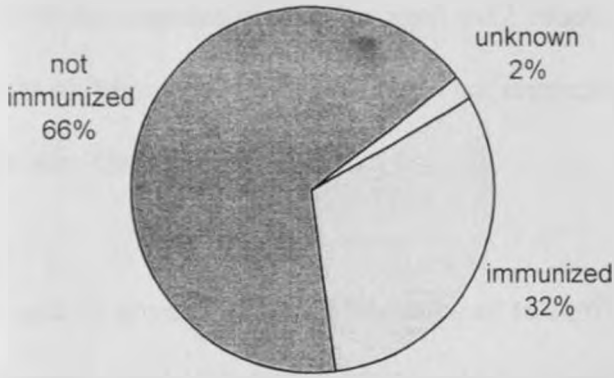
		Frequency	%
HAZ	<-2	36	39
	>-2	56	61
WAZ	<-2	32	35
	>-2	60	65
WHZ	<-2	8	9
	>-2	84	91

Among the 92 children studied, 48(52%) were malnourished and 44(48%) were of normal nutritional status. The most frequent form of malnutrition was stunting present in 36(39%) children followed by underweight in 32 (35%) and wasting in 8(9%).

## Measles vaccination status

Review of the measles vaccination status according to mother/guardian verbal report or immunization card evidence, data was obtained for ninety out of the ninety-two measles cases. The results are shown in figure IV.

**Figure IV: Measles Immunization status**



Measles vaccination status was determined by maternal verbal report for eighty-seven (97%) of the ninety children. Sixty one (66%) of the ninety children had no prior history or record of measles vaccination. About one third, 29(32%) were vaccinated and (2) 2% were of unknown immunization status.

Cross tabulation of age versus immunization status is as shown in table 3

**Table 3: Age versus immunization status**

Immunization status (%)	Age in months				Total
	<9	9-12	13-60	>60	
Immunized	1 (1)	3 (3)	19 (21)	6 (7)	29 (32)
Unimmunized	29 (32)	7 (8)	23 (25)	2 (2)	61 (66)
Unknown immunization status	-	-	1 (1)	1 (1)	2 (2)
<b>Total</b>	<b>30 (33)</b>	<b>10 (11)</b>	<b>43 (47)</b>	<b>9 (10)</b>	<b>92 (100)</b>

Most of the immunized children 19/29(66%) who contracted measles aged between 13-60 months while 3/29(10%) aged 9-12 months and 6/29(21%) were above 60 months old. Almost all the children 29/30(97%) aged less than 9 months were not immunized. About 8/10(80%) of the measles cases who aged 9-12 months were not immunized while 23/43 (53%) of the children aged 13-60 were also not immunized and 2/9(22%) of those older than 60 months were unimmunized.

Of those aged <9 months 1/30 (3.3%) compared to 28/62 (45%) of 9 months and above who were vaccinated ( $\chi^2=16.39$ ;  $P=0.0000516$ ) which is statistically significant.

OR=0.04 (0.00-0.32)

**Reason for non vaccination**

Sub analysis of non-vaccinated children to describe the reasons for non-vaccination is as shown in table 4.

**Table 4: Reasons for non-vaccination (n=61)**

Reason for non vaccination	Frequency	Percent
Age < 9 months	30	49
Missed opportunities	14	21
Others*	17	30

\* Includes child unwell, lack of funds and mother deferred taking child for vaccination.

Reasons for non-vaccination of the sixty-one children in the study included being underage 30/61(49%), missed immunization opportunities, due to sick child, lost clinic card and lack of vaccine, 14/61(23%) and other reasons such as mother deferred cases due to child's sickness, forgetting, lack of funds or child being orphaned 17/61(28%).

### Missed Immunization opportunities

Situations which resulted in missed immunization opportunities for 27 children otherwise eligible for measles immunization are shown in table 5.

**Table 5: Reasons for missed immunization n=27**

Reason for non-immunization	Frequency	Percent
Health worker deferred cases due to		
▪ Child sick	10	37
▪ Missing clinic card	3	11
▪ Lack of vaccine	1	4
Cases contracting measles from health facilities		
▪ 6-9 months*	10	37
▪ > 9 months**	3	11
Total	27	100

\* These children were eligible for early post exposure measles vaccination

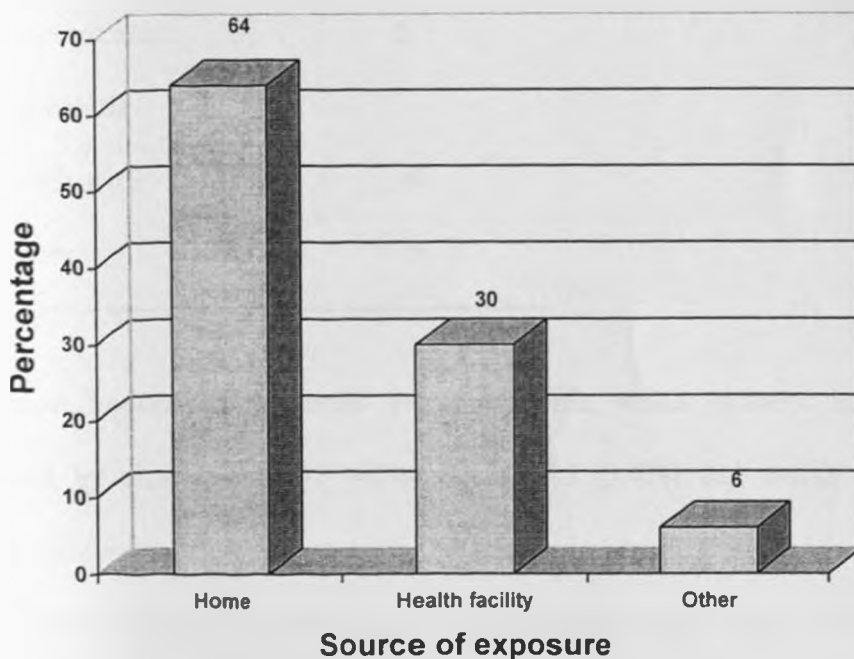
\*\* These children were eligible for late measles immunization (aged > 9 months) and also post exposure measles vaccination but missed in both situations.

Out of the 61 unvaccinated children, 27 (44%) were missed immunization opportunities (including those aging upto 6-9 months who had missed opportunities). Mothers of 14 children sought measles immunization but vaccination was deferred by the health worker due to concurrent illness (n=10), a missing clinic card (n=3) or unavailability of vaccine(n=1). Similarly, three nosocomial measles cases aged 9 months or older had missed post exposure measles immunization as the health workers failed to assess their immunization status during their hospitalization.

### Source of exposure

Figure V shows the areas deemed to have been the place of contact for those children who contracted measles

**Figure V: Source of exposure**



A total of 69 (75%) cases had positive history of recent contact with measles, 23 (25%) had no history of contact with measles cases Measles contact occurred at or within the neighborhood for 44 (64%) children, in health facilities for 21 (30%) children had exposure in health facilities (10 in-patients and 11 out-patients).

**Patient outcome on follow up.**

The majority, 91 (99%) of the children recovered from measles. One child died giving a case fatality of 1%.

Acute complications of measles experienced by study cases are shown in table 6.

**Table 6: Measles complications**

Complication	Frequency	Percentage
Pneumonia	73	79
Diarrhoea	37	40
Laryngotrache obronchitis	5	5
Mouth sores	4	4
Others	8	9

The most frequent complication was pneumonia, which occurred in 73 (79%) children, followed by diarrhoea in 37 (40%), LTB in 5 (5.4%) and mouth sores 4 (4%). Other complications included gastroenteritis, vomiting, impetigo, convulsions and petechie.

The median duration of hospital stay was 5 days and ranged from 1-123 days. Some of the children contracted measles during hospitalization for other chronic illness.

## DISCUSSION.

Occurrence of measles prior to the national recommended age for measles immunization was a common contributing factor to measles cases presenting to KNH, with 32% of the cases acquiring measles before 9 months, and the youngest child aged 3 months. More than one half, 66% of the study cases was less than 2 years old. Approximately one third (37%) of the children were between 12-35 months, which is lower than that seen in pre-immunization era during which every child contracted measles before the age of 2 years<sup>2</sup>. This differs greatly with an observation by Tumwine in Zimbabwe where a reduction in measles and age distribution of measles was noted to have shifted to older children. The lowest measles incidence rate of 0.8/100 children occurred in the 0-5 months age group and the highest incidence rate of 4% in the 48-59 months age group with only 7.9% of the measles cases occurring in children under nine months of age<sup>37</sup>. The number of cases in the under 5 years age group in the study is higher than that found in other studies within Nairobi<sup>29</sup>.

The variability in age distribution of the study cases and the other studies could be due to different study designs. Age estimation in this study was accurate (calculated from date of birth) while in the other studies it was from reported listed cases. A high incidence of measles before age of immunization is common in many developing countries. In Kenya, early age of measles infection in urban areas remains a major problem in controlling this disease.

Immunization of children using a single dose of vaccine at 9 months of age could reduce the transmission of measles among older children and hence reduce exposure to infants under 9



months. This effect has not been observed even after many years of immunization because very high immunization coverage is needed in order to interrupt transmission. The extreme intensity of measles transmission during an outbreak in an isolated community, although only lasting for a short period presents a serious risk for young infants not yet immunized. Implementation of current KEPI measles immunization recommendation would reduce the occurrence of measles in the under 9 months old children.

Most of the study cases, 66% (61/92) had not received measles vaccine while 32% (29/92) had. A small number, 2% (2/92) had their vaccination status unknown. The measles vaccination status for most of the children (98%) was known. The high rate of unvaccinated children found in the study was higher than 29% unvaccinated measles cases found in a study which analyzed 6573 reported measles cases in Kenya (January 1992-June 2000) <sup>29</sup>.

The high number of unvaccinated children contracting measles could be associated with the reported decline in measles immunization coverage in Kenya from 79% to 56% (KEPI vital statistics 2000) and the occurrence of measles in infants less than 9 months in one third of the study cases. The decline in immunization coverage may be a result of increasing poverty in the community from 45% (1992) to 52% (1997) and recently to 56% (2001) <sup>38,39,40</sup>. The low immunization coverage may also be due to the withdrawal by major bilateral donor assistance in KEPI with increased financial support of KEPI programs by the government from total foreign support in 1996 to 31% by 2001 <sup>41</sup>. Continued education of health personnel and caretakers on importance of immunization may help improve on the immunization coverage.

The early age of contracting measles could also be due to low immunity acquired in utero due to decline in mother's immunity against measles. HIV infection could also predispose to high early measles prevalence although the HIV infection rates have relatively been stable in Nairobi with a maximum rate of 17% in 1999 and a recent decline to about 14% by 2002 <sup>42</sup>. Kenyan infants born to HIV seropositive mothers were found to have a four fold risk of measles before the age of 9 months compared to infants born to HIV seronegative mothers, although in the same study, 94% of infants born to HIV positive and negative mothers were found to be non-immune to measles at 6 months age on the basis of ELISA antibody testing <sup>43</sup>. The loss of maternal antibodies to unprotective levels was also reported in 88% of 6 month old infants with all infants at 9 months age being susceptible supporting early immunization at 6 months <sup>44</sup>.

These children contracting measles in early infancy could be protected by immunization with EZ vaccine, which was found to be less sensitive to maternal antibodies and with increased antibody response revaccination better than Schwartz vaccine <sup>45</sup>. The EZ vaccine was also found to be a safe preventive measure for measles especially where age specific attack rate for children less than 9 months is high <sup>46</sup>.

Among the children who had acquired measles nosocomially, 52% (11/21) occurred in children who were not eligible for the recommended KEPI measles immunization age. There is no local report on the occurrence of nosocomial measles but this is marginally lower than that found by Davis (1986) in the U.S, where 59% of Nosocomial acquired measles cases were ineligible for measles immunization <sup>47</sup>. The small difference could be due to the

different study designs and epidemiology of the disease in both places. Most of the children, 96% were born at term gestation. Active transfer of antibodies via the placenta occurs after week 32 of gestation in normal pregnancies resulting in cord blood concentration of measles antibodies 1.5-1.7 times that in maternal blood, with preterm infants having lower concentration of passively acquired antibodies<sup>48</sup>. Since most of the studied measles cases were born term, length of gestation would not explain the high early occurrence of measles in the under 9 months children.

The results show a vaccine failure rate of 32%, which falls within locally, reported failure rates of 28 and 39%<sup>30</sup>. This failure rate is higher than the theoretical expected rate of 10-20% in developing countries<sup>49</sup>. This difference could be due to an over reporting of the vaccination coverage by history which was also shown by Tumwine et al who reported complete vaccination coverage by card of 26% while by history and card was 44.6%<sup>50</sup>. The immune response of measles antibodies to measles vaccination increase with age as maternally inherited antibodies decrease. Due to the presence of maternal antibodies, measles vaccine is not 100% effective with an estimated 10-20% of the children not producing antibodies to the disease when vaccinated at 9 months age<sup>29</sup>.

**MEDICAL LIBRARY**  
**UNIVERSITY OF NAIROBI**

The presence of maternal antibodies cannot explain the high observed vaccine failure rate since most of the children were vaccinated after 9 months. The failure could be due to factors such as use of measles vaccine that had lost potency due to poor storage attributed to frequent power shortages since many of the fridges used for storage are dependent on electricity. There could also be misdiagnosis of other infections with similar rash and fever.

Patients should be assured that immunization is protective since after immunization most of the cases are mild compared to those who had not received immunization. Efforts should be made to maintain the cold chain system at all levels especially in outreach facilities. Alternative power supplies should be sought to maintain the cold chain when there is power failure. Regular check on the cold chain system may be necessary. The child's health card should include a reference of the health facility immunization was given in an attempt to localize health facilities with high failure rates of the immunization for intervention.

Approximately one half, (49%) of the unimmunized measles cases were under 9 months old. The young infants contracted measles before the current KEPI routine measles immunization age. The contraction of measles in many young infants could be due to poor maternal immunity against measles hence poor acquired immunity by the children, increase in HIV infection which may predispose the infants to contract the disease early and occurrence of nosocomial measles with lack of post exposure prophylaxis. Most of the study cases were inpatients and measles in infants is more severe associated with many complications.

Isolation of the infants in congested health facilities would reduce this rate. In special circumstances children as young as 6 months may be included in supplemental measles immunization campaigns though they should receive another dose of measles vaccine at 9 months to ensure protection because half of those vaccinated before 9 months, may not develop immunity<sup>24</sup>. Implementation of post exposure vaccination in children between 6 and 9 months old should be improved by having immunization facilities in PFC.

Almost one half, 44% of the unimmunized children were missed measles immunization opportunities. Some cases, 48% (13/27) were deferred by the health worker due to child's sickness, absence of the child's clinic card and lack of measles vaccine in health facility. Among the other 13 missed opportunity cases 10 aged, between 6 and 9 months but had nosocomial measles. The observed missed immunization opportunity is lower than that reported by Wainaina, 57.5% but higher than that reported by Sonoiya and REACH.<sup>32, 30,31</sup>. The greatest contributor to not offering measles immunization was illness of the child. Both the health worker and caretakers falsely believe that illness of a child is a general contraindication to measles immunization.

Missed immunization opportunities because of false contraindication, incorrect screening of immunization cards and improper immunization history are a major cause of delay in completing the immunization schedule. Non-compliance by health workers with the age of immunization and intervals between doses as established by KEPI decreases immunization coverage by 34%<sup>30</sup>. The observed rate is similar to findings of other missed opportunity studies<sup>50,51,52</sup>

Among some of the cases, the children were ill and the caretakers decided not to take the children for measles immunization. This may result from learnt behavior by the caretaker from health workers practices. Caretakers should be educated and informed to take their children to health facilities and allow the health worker to decide on the immunization of the child. Continued education of the health worker is necessary on the true contraindications and immunization scheduling. Systematic efforts must be made to eliminate all missed

opportunities for immunization. Proper immunization history should be obtained and children eligible immunized.

Some of the caretakers had lost the child's immunization cards making the health worker defer the immunization contributing 11% of missed opportunities. This is higher than 8% observed in another local study in the general population<sup>50</sup>. Child health card retention at the time of interview with the caretaker was negligible. The guardians should be educated on the importance of the health cards. When the child falls sick, the cards should be carried to the health facility and this would help in easier accurate screening of the immunization status of the children. The health workers should be understanding and vaccinate children whose caretaker's have lost the health cards.

Among all the cases 69 (75%) had a positive history of measles exposure to an index case while 25% had no identifiable exposure. Of the cases with positive exposure, domestic exposure accounted for 64% while 30% had contact in health facilities either as inpatients or outpatients (nosocomial measles). This rate of nosocomial measles falls within the range found in measles outbreak investigations which reported exposure in health facility settings rating between 21% to 71%<sup>53</sup>. Other similar reports were found in community-based studies<sup>54,55</sup>. Data from developed countries indicate that nosocomial measles rate range from 15-72% which include that found in this study<sup>47,23,56</sup>.

It is evident that hospital contact is an important mechanism of measles transmission in our set up. Routine immunization schedules limiting immunization to children 9 months of age

and older fail to protect susceptible infants under nine months of age. This may occur because there is no proper implementation of new KEPI policy for immunizing children at every contact with patient in health facilities. Congestion, low relative humidity and lack of fresh air circulation in our waiting areas may facilitate measles transmission. The incubation and prodromal stage of the disease with nonspecific features may make it difficult to identify the cases for isolation to prevent the transmission.

This can be improved by checking the immunization status of the patients, offering post exposure prophylaxis among eligible infants and children as well as offering immunization facilities in PFC. Staff in the immunization center should make daily visits to the pediatric wards immunizing eligible children. The general condition of the PFC should be improved to avoid congestion. The young infants should be attended to on arrival to avoid exposure to measles cases and other infectious diseases.

Slightly less than one half, 48% of the cases had normal nutritional status. Stunting was observed in (36/92) 39%. This is higher than the reported 33%, summary statistics in the general population (KDHS1998). More than one third, 35% of the children were underweight which is slightly higher than 33% in the general population. (KDHS 1998). About 9% of the children had wasting which is higher than 6% in the general population. The measles cases therefore had a higher prevalence of malnutrition states compared to the known states in the general population.

Measles and nutritional status of the child form a complex interrelationship. The fever diarrhoea and the loss of appetite may severely impair the nutritional status of the child with measles. There is increased severity of measles in malnourished children with higher attack rates. Primary caretakers should be educated on nutritional requirements and support of children when sick with measles. Reduction in poverty level would help reduce malnutrition rates hence less attack rates and severity of measles. Health workers should be supportive in management of measles cases ensuring adequate nutritional support particularly in those children with complicated measles.

Bronchopneumonia complicated 73(76%) of the 92 study cases. It is the most common known complication associated with measles. This rate is similar to that seen in India with a range of 50-90%<sup>57</sup>. Morley and Bwibo reported lower rates of 47% and 50.6% at similar settings in developing countries respectively<sup>58, 59</sup>.

Gastroenteritis complicated 38/92 (41%) cases. It is another known common complication. Similar rates of measles gastroenteritis were reported in India, 27-62%<sup>60</sup> and 20-72% by Feecham et al<sup>61</sup>. Other observed complications include LTB 5/92 (5.9%), otitis media, stomatitis and petechie 9/92 (9.8%).

Measles complications are highly preventable by measles immunization. When the complications occur, aggressive specific management and support of the child is necessary to reduce morbidity and mortality.



Most of the children in the study, 99% recovered. One child died giving a case fatality of 1% which is higher than 0.6% reported from 1997 to 2000 <sup>29</sup>. It is however lower than 10.1% reported earlier in Kenya by Donovan <sup>6</sup> with an under age case fatality of 2.2%. Voouhoeve et al reported a higher case fatality of 6.1% <sup>7</sup> between 1974 and 1976 which was similar to that reported by Williams and Hull <sup>62</sup> in Gambia.

This shows a possible decline in mortality among measles cases. The decline could be due to improved measles immunization and the current decline trend of immunization coverage should be addressed urgently in order to prevent increase in morbidity and mortality.

## CONCLUSIONS

1. Measles vaccine failure is frequent, occurring in 32% of pediatric measles cases presenting to Kenyatta National Hospital.
2. Measles occurrence prior to the age of 9 months is frequent occurring in 33% of pediatric measles cases presenting to Kenyatta National Hospital.
3. Missed opportunities for measles vaccination was present among 44% of unvaccinated children who were otherwise eligible for vaccination: common reasons being obstacles laid by the health workers and improper screening of immunization eligibility in children visiting health facilities.
4. For one third of measles cases with identifiable contact with measles, exposure occurred during an earlier visit to a health facility.

## RECOMMENDATIONS

There is need for introduction of immunization facilities in PFC to reduce missed immunization opportunities and nosocomial immunizable diseases. We recommend continued education of health workers on true contraindications of measles vaccine and the importance of proper screening of children visiting health facilities in order to limit missed opportunities for immunization. There is need for further research to validate the occurrence of vaccine failure and its causes. Action is required to improve early identification and isolation of measles cases at outpatient and in-patient health facilities to reduce incidence of nosocomial measles transmission.

## Appendix I

### QUESTIONNAIRE

#### A. OUTPATIENTS

1. Study Number \_\_\_\_\_
2. Name of the patient -----
3. Date attended \_\_\_/\_\_\_/\_\_\_\_\_
4. Outpatient Number -----
5. Informant    Mother        -----  
                  Father        -----  
                  Grandparents -----  
                  Sibling        -----  
                  Guardian      -----  
                  Others        -----        Specify -----
6. Current residence  
                  Location -----  
                  Village -----
7. Sex            Male        -----  
                  Female-----
8. Date of Birth \_\_\_/\_\_\_/\_\_\_\_\_
9. For children under 5 years of age in months -----
10. For children above 5 years age in years        -----
11. Number of siblings                                -----
12. Was measles immunization given? Yes ----- No -----

3. If yes, evidence from child's card -----  
 Report from mother -----  
 Report from guardian -----
14. If yes, when the immunization was given  
 <9 months -----  
 9 – 12 months -----  
 >12 months -----
15. If immunization was not given, reasons for missing  
 Baby sick -----  
 No vaccine -----  
 No needle/syringe -----  
 Previous measles -----  
 Mother forgot -----  
 Mother not informed -----  
 Others specify -----
16. If health workers advice – specify -----
17. Maturity at birth  
 Term ----- Preterm -----
18. Birth weight \_\_\_\_\_
19. History of severe illness in the past one month Yes ----- No -----
20. Diagnosis at recent severe illness -----
21. History of recent contact with patient with measles Yes ----- No -----

22. Relationship of index case to the patient

Sibling -----

Relative -----

Neighbour -----

Classmate -----

Others ----- Specify -----

23. Place of contact

Home -----

Inpatient health facility -----

Outpatient health facility -----

School -----

Others ----- Specify -----

24. Current weight in Kg (to the nearest 100 gms) -----

25. Length in cms (children under two years) -----

Height in cms (children above four years) -----

**Current illness**

26. Duration of signs symptoms in days -----

27. Clinical presentation

Fever Yes ---- No ----

Cough Yes ---- No ----

Corhyza Yes ---- No ----

Rash Yes ---- No ----

Pneumonia Yes ---- No ----

Diarrhoea Yes ---- No ----

Others Yes ---- No ---- If yes specify -

**B. INPATIENTS QUESTIONNAIRE**

1. Study number \_\_\_\_\_
2. Name of patient -----
3. Ward -----
4. Date attended   /  /
5. Date of admission   /  /
6. Inpatient number -----
7. Informant    Mother        -----  
                   Father        -----  
                   Guardian      -----  
                   Grandparents -----  
                   Sibling        -----  
                   Others         -----        Specify -----
8. Current residence    Location        -----  
    Village/Estate -----
9. Sex    Male    -----        Female-----
10. Date of Birth   /  /
11. For children under 5 years, age in months        -----
12. For children above 5 years, in years                -----
13. Was measles immunization given?        Yes -----        No -----
14. If yes, verify from child's card                -----  
    Verbal report from mother        -----  
    Verbal report from guardian      -----

15. If yes, age at which immunization was given

<9 months -----

9-12 months -----

>12 months -----

16. If immunization was not given reasons for missing

Sick baby -----

No vaccine -----

No needle/syringe -----

Previous measles -----

Mother forgot -----

Mother not informed -----

Others specify -----

17. If health workers advice specify -----

18. Maturity at birth

Preterm ----- Term -----

19. Birth weight in Kg to the nearest 100 gms -----

20. History of severe illness in the past one month Yes ----- No -----

21. If yes, diagnosis at recent severe illness -----

22. Relationship of index case of contact to the patient

Sibling -----

Relative -----

Neighbour -----

Classmate -----

Others ----- Specify -----

23. Place of contact

Home -----

Inpatient health facility -----

Outpatient health facility -----

School -----

Others ----- Specify -----

24. Current weight in Kg to the nearest 100 gms -----

25. Length in cm (for those under two years) -----

Height in cm (for those above two years) -----

**Current illness**

26. Duration of symptoms in days -----

27. Clinical presentation Fever Yes ----- No ----

Cough Yes ----- No ----

Corhyza Yes ----- No ----

Rash Yes ----- No ----

Conjunctivitis Yes ----- No ----

Others Yes ----- No ---- Specify -----



28. Day 3 of admission

On treatment and improving Yes ---- No -----

On treatment deteriorating Yes ---- No -----

Discharged Yes ---- No -----

Dead Yes ---- No -----

29. Day 7 of admission

On treatment and improving Yes ---- No -----

On treatment deteriorating Yes ---- No -----

Discharged Yes ---- No -----

Dead Yes ---- No -----

30. Occurrence of acute complication of measles

Pneumonia Yes ---- No -----

Diarrhoea Yes ---- No -----

LTB Yes ---- No -----

Conjunctivitis Yes ---- No -----

Malnutrition Yes ---- No -----

Others Yes ---- No ----- Specify -----

31. Date of discharge \_\_/\_\_/\_\_\_\_

32. Diagnosis at discharge -----

33. Date of death \_\_/\_\_/\_\_\_\_

34. Cause of death

Pneumonia .....

LTB .....

Diarrhoea/dehydration .....

Malnutrition .....

Encephalitis .....

Others (specify) .....

## REFERENCES

1. Carol F. Philips in: Nelson's Textbook of Paediatrics. Editors: Behrman, R.E., Kliegman, R.M., 13<sup>th</sup> ed. Ch. 11, p. 655 W.N. Saunders Co., Philadelphia, 1987.
2. State of the world's vaccines and immunization. World Health Organization, United Nations Children's Fund, Geneva 1996. WHO/GPV/96.04.
3. Reddy V., Bhaskaram P, Raghuramulu N. et al. Relationship between measles, malnutrition and blindness a prospective study in Indian Children. *Am J. Clin Nutr.* 1986; 44:924.
4. Koster F.T., Curlin C., et al. Impact of measles diarrhoea on nutrition and mortality in Bangladesh. *Bull WHO*, 1981; 59:501.
5. Morley D. Woodland M. and Martin W. J. Measles in Nigerian children *JH Camb* ; 1963;61:115.
6. O'Donovan, C: Measles in Kenyan children, *E. Afr. Med.* , 1971; J 48:526.
7. Voorhoeve, A.M., Muller, A-S, Schulp, TWJ, Agents affecting health of mother and child in a rural area of Kenya. The epidemiology of measles. *Trop. Geogr. Med.* , 1977; 29. 428.
8. Enders, F. Development of Attenuated Measles Virus Vaccines: A summary of a recent investigation. *Am J. Dis Child*,1962; 103:165.
9. Enders, J.F., Peebles TC. Propagation of auto-pathogenic agents from patients with measles. *Pro. Soc. Exp. Biol and Med*, 1954; 86:277.

10. Schwartz A.J.F, Bayer P.A. et al. Experimental vaccination against measles. Tests of live measles and distemper vaccine in monkeys and two human volunteers under laboratory conditions. *JAMA* 1960; 173:861.
11. Krugman S: Present status of measles and rubella immunization in the United States: A medical progress report. *J Paediatr.* 1971; 78:1.
12. Hayden R.J: Epidemiology and nature of measles in Nairobi before impact of measles immunization. *E. Afr. Med. J* 1974; 51:199.
13. Measles control in the 1990's WHO/EPI/GEN 94-7 .
14. WHO International; vaccine Immunisation and biologicals measles vaccine; WHO perspectives Pg. 1 of 5.
15. Measles Eradication: Recommendations from a meeting co-sponsored by the WHO, PAHO and CDC. *MMWR* 46 (RR11): 2.
16. Kenya Demographic and Health Survey, 1998. National Council for Population and Development, Central Bureau of Statistics, Office of the Vice President and Ministry of Planning and National Development, Nairobi, Kenya.
17. Ministry of Health Appraisal Report on Expanded Programme of Immunisation. A joint MOH/DANIDA Report, Kenya. 1<sup>st</sup> Edition, November 1978.
18. KEPI, Management unit. National Immunization Coverage Survey Kenya: 1987. A Ministry of Health Publication, 1987.
19. Bjerregaard P, Mutie DM. Immunization Coverage in Kenya; *E Afr. Med. J* 1988; 65: 811 – 819.

20. National Council for Population and Development (Min of Home Affairs and National Development). The Kenya Demographic Health Survey 1989.
21. Measles vaccination in developing countries; A symposium on current issues. Trans. R.Soc. Top. Med. Hyp. 1975; 69:29.
22. Collaborative study by the ministry of health of Kenya and WHO: Measles immunity in the first year after birth and optimum age for vaccination in Kenyan children. Bull. WHO1997.;55:21.
23. Expanded programme of immunization. The optimum age for measles immunization weekly epidemiological record 1982;. 57:89
24. Afro. EPI newsletter issue No. 016 Oct.1 pg. 2. Vaccine preventable disease bulletin WHO/AFRO: Target age for measles immunization.
25. EPI. progress towards global measles control and elimination, 1990-1996, wklyEpidem rec.1997; 72:349-53.
26. Cutts F. T., Henao-Retrepo A. M. and Olive J. M., Measles elimination; Progress and challenges. Vaccine 1999; 17 suppl 3: 547-52.
27. Anonymous. Global measles control and regional elimination 1998-1999. Morbid. Mortal. wkly rep. Atlanta. 1999; 48:1124-1130.
28. Dequadros C. A., O Live J.M., Hersh B S., et al. Measles elimination in America: evolving strategies. J.Amer med Ass. 1996;275:224-229.
29. Plan of Action (2001 – 2005) for Accelerated Control of Measles in Kenya Draft September 2000. Ministry of Health, Kenya Expanded Programme of Immunization.

30. Sonoiya S.D: Factors influencing measles immunization in children of an urban slum: 1993.
31. Resources for child health project (REACH USA) Assisted by KEPI: 1992.
32. Wainaina L.N. Missed opportunity for immunization in paediatrics inpatient and outpatient in Kenyatta National Hospital. March 1996.
33. Hutchin's et al immunization policy. WHO. EPI GEN 95.03 Rev 1 PP 14.
34. Scheifele D.W and Forbes, C.E. Prolonged giant cell excretion in severe African measles paediatrics. 1972; 50:867.
35. Doseter J., Whistle.H. C and Green Wood. Bm: Persistent measles infection in malnourished children. Brit.med.J. 1977;1:1633.
36. Sample size determination; A users manual. WHO/HST/ESM/86.1(Rev.-1).
37. Tumwine JK. Measles control in a rural area in Zimbabwe: East afr med j. 1991 sep;68(9):694-701.
38. First Report of Poverty in Kenya 1992. Vol 1: Incidences and depth of Poverty in Kenya pg 8.
39. Kenya bureau of statistics. Welfare monitoring survey: Estimated poverty line as per 1997.
40. Unpublished data: Kenya Institute of Puplic Policy and Research Analysis (KIPPRA) 2001
41. The state of world's children, UNICEF 1998 AND 2001.

42. Republic of Kenya. National AIDS/STD control programme AIDS control unit MOH. HIV surveillance report 2002. Research monitoring and evaluation unit December 2002.
43. Embree, J.E., Datta, P. and Stackiw W. et al. Increased risk of early measles in infants of human immune deficiency virus type 1 sero-positive mothers. *J. Infec. Dis.* 1992; 165:262-7.
44. Kiepiela P, Coovadia H M Loening W E, Coward P, Abdool Karim S S. Loss of maternal measles antibody in black South African infants in the first year of life – Implications for age of vaccination. *S Afr. Med J.*1991 Feb 2;79(3):145-8.
45. Garly Ml, Bale C, Martins CL, Montevid M, George E, Kidd M, Das F, Haby P, Whittle HC. Measles antibody response after early two doses trials in Guinea Bissau with E-Z and Schwartz standard titre measles vaccine: Better antibody increase from booster dose of the EZ vaccine; *vaccine* 2001, Feb 28:19 (15 –16): 1951 –9.
46. George K. Joseph A, Muliyl J, Abraham S, Bhattacharjis, John KR: Measles vaccination before nine months *Tropical Med. Int. Health* 1998 Sept.: 3(9): 751 –6.
47. Davis, R.M., Ovenstein, W.A., Frank, J.A., Sacks, J.J., Rales L.G, Preblud, S.R., Bart, K.J., Williams. N.M., Hin, Man, A.R., 1986; Transmission of measles in medical settings; 1980 through 1984, *Journal of American Medical Association*, 255 (10): 1295-129.
48. Sato H., Albrecht P., Reynolds D.W., Stagnos,Ennis FA. Transfer of measles, mumps and rubella antibodies from mother to infant. *Am J. Dis. Child* 1979;133;1240-3.
49. Hull, 1993; PAHO, 1984; WHO, 1984; Dahis,1998; Thapa,1982.

50. Tugumisirize F, Tumwine J K, Mworozzi E A. Missed opportunities and caretakers constraints to childhood vaccination in rural area in Uganda: East Afr Med J. 2002 Jul;79(7):347-54.
51. Hutchins, S.S., Jansen, H.A., Robertson S.E., et al: Studies of missed opportunities for immunization in developing and industrial countries: Bull. WHO 1993, 71:549-560.
52. CJ, Clements: EPI measles control in the 1990s. Minimizing nosocomial transmission: WHO/EPI/GEN 94 -6
53. PAHO, 1984; Chen, 1990; Guyer, 1976; Klein - Zabban, 1987; Aaby, 1985 (Aaby, P., J: Lure 1M) and Smits, AJ 1985: Introduction of measles into a highly immunized community: The role of health care institutions. Journal of Epidemiology and Community Health 39:113 - 116.
54. PAHO, 1983; Guyer, 1976; Rabelo, 1982; Aaby, 1985.
55. Cotton M.F., Berkowitz F.E. Berkowitz Z. et al . Nosocomial infection in black South African children. Pediatric Infectious Diseases.1989; 8:676 - 683.
56. CDC 1981, 1986, 1988, 1984, 1987: Davis 1986; Gindler, 1992; Istre, 1987; Dales 1985; Foulon 1986; Sienko 1987; Reynolds 1987; McGrath 1992; Mason 1993; Farizo 1991.
57. Dave, K.H.: Measles in India. Rev. Infect. Dis. 1983; 5:406.
58. Morley, D.: Severe measles in the tropics. I. Brit. Med.J. 1969; 1:363.
59. Bwibo, N.O: Measles in Uganda Trop. Geogr. Med. 1970; 22: 167.

**MEDICAL LIBRARY  
UNIVERSITY OF NAIROBI**



60. Prongvithsukda, V., Phonboon, K. and Manunpich, K.: Measles associated diarrhoea in North Eastern Thailand South East Asia, *J. Trop. Med. Pub, Hlth*, 1986; 17: 43.
61. Feechem, F.G. and Kloblisky, M.A.: Interventions for the control of diarrhoeal diseases among young children: Measles immunization *Bull. WHO* 1983; 61.
62. Williams. P.J. and Hull, H.F.; Status of measles in Gambia 1198 I. *Rev. Infect. Dis.* 1983. 24; 5:391.