# AUDIT OF MANAGEMENT OF SUSPECTED BACTERIAL MENINGITIS IN NAIROBI
# A CASE STUDY OF KENYATTA NATIONAL HOSPITAL AND MBAGATHI COUNTY HOSPITAL


**BY**

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# DECLARATION

This dissertation is my original work and has not been presented for the award of a degree in any other university.

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Last but not least, I would like to thank God almighty, without whom none of this would have been possible.

## LIST OF ABBREVIATIONS

**ABM**- ACUTE BACTERIAL MENINGITIS

**CDC-** THE CENTRE OF DISEASE CONTROL AND PREVENTION

**CNS**- CENTRAL NERVOUS SYSTEM

**CSF**- CEREBRAL SPINAL FLUID

**CT**- COMPUTED TOMOGRAPHY

**EFNS**-EUROPEAN FEDERATION OF NEUROLOGICAL SOCIETIES

**GCS**- GLASGOW COMA SCALE

**HIV**- HUMAN IMMUNODEFICIENCY VIRUS

**IV**- INTRAVENOUS

**KNH**- KENYATTA NATIONAL HOSPITAL

**LP**- LUMBAR PUNCTURE

**NEWS**- NATIONAL EARLY WARNING SCORE

**OP**- OPACITY PROTEINS

**PCR**-POLYMERASE CHAIN REACTION

**PI-** PRIMARY INVESTIGATOR

**PRP**-PATTERN RECOGNISTION RECEPTORS

**TFP**- TYPE FOUR PILI

**TNF**- TUMOR NECROSIS FACTOR

**UK**- UNITED KINGDOM

**WHO**- WORLD HEALTH ORGANIZATION

## DEFINITIONS

**Audit**: an official inspection of an organization's accounts, typically by an independent body

**Incidence:** the number of new cases per population at risk in a given time period

**Pathophysiology:** Disordered mechanical, physical and biochemical changes associated with a disease process

**Prevalence:** Proportion of a given population with a particular condition at a specific point in time

# DEDICATION

I would like to dedicate this book to my parents Dominic Githua and Cecilia Githua as well as my siblings Solomon and Elizabeth Githua and last but not least my dear son Kaizer Githua.

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# ABSTRACT

**Background:** Acute bacterial meningitis is one of the major causes of mortality causing around 135,000 deaths annually worldwide, with neurological sequel in around 21% of the survivors. In low income countries in sub Saharan Africa, the mortality rate is as high as 50%. Despite this, the countries are yet to develop standards to guide in the management of adult bacterial meningitis.

The aim of this study was to determine the various practices (diagnostic and treatment practices) in the management of bacterial meningitis and evaluating them against the UK specialist guidelines 2016.

**Objective:** The main objective of this study was to audit the practices in the management of suspected bacterial meningitis at Kenyatta National Hospital as compared to the UK specialist guidelines 2016.

**Study significance**: This study helped highlight some of the gaps in the management of ABM and will help standardize treatment of ABM using the data already collected from this study

**Methodology:** The study was carried out at KNH and Mbagathi District hospital. The study was carried out prospectively using an edited version 10Wi Meningococcal 2016 auditing tool on patients admitted in the medical wards with a diagnosis of bacterial meningitis. The PI noted the various diagnostic tests done on day 1 of admission; the time of antibiotic initiation and the appropriateness of the treatment by visiting the post admission ward. Further assessment of change in management based on outcomes of diagnostic tests was also done. Duration of antibiotics was assessed and the outcome of the patient documented.

Data analysis was done using the SPSS Chicago Illinois version 21. Continuous variables were represented as means and standard deviations while categorical variables were presented as proportions. Duration before lumbar puncture and before initiation of treatment was analyzed using the inter-quartile ranges.

**Results**:70 patients were recruited for the study. 6 were excluded as they were on management for cryptococcal meningitis while 1 was on management for TBM. 63 patients participated in the study, 41 from Mbagathi and 22 from KNH. 37(58.7%) of the study participants were male while 26 (41.3%) patients are female. Only 71% had LPs done with 56.2% having CT scan done after LP. Opening pressure was not recorded in 93.7% of the participants. The median duration when an LP was performed was 3 days. The right empiric treatment was given in 82.5% of the participants however none of the patients were changed to a definitive treatment once CSF results were out. The median duration of treatment was 10 days. Treatment was initiated 2 hours after admission. The mortality rate was 16%. The compliance of our study to the UK specialist guidelines was 39.03%.

**Conclusion:** The compliance of our study to the UK specialist guidelines was 39.03%. Therefore, management of suspected bacterial meningitis is not in line with the UK specialist guidelines 2016 both in diagnostic assessment and management of these patients

# CHAPTER ONE: INTRODUCTION

Bacterial meningitis still carries a significant morbidity and mortality worldwide despite the use of antibiotics. A retrospective cohort study conducted across four hospitals in Connecticut on community-acquired bacterial meningitis assessed the outcome of patients being managed for bacterial meningitis that had been confirmed on CSF studies. The study found the case mortality rate was 25% while 21% of the survivors had permanent neurological sequele(1).

Over the last 50 years' various studies have been done to assess the incidence of bacterial meningitis. Several retrospective studies in the 1950s showed that over 70% of the cases of acute bacterial meningitis were caused by Haemophilus influenza, Neisseria meningitides and Streptococcus pneumoniae(2). Most of these studies involved a small population and it did not take into account any active cases. The Centre of Disease Control and prevention (CDC), in 1977, undertook a prospective study to get real time data on the incidence of bacterial meningitis. They set up a nationwide surveillance run over three years. The study concluded that H.Influenza, N.meningitidis and S.pneumoniae accounted for 80% of the cases despite the significant under reporting of active cases in the study. A follow up study was done to remedy this with a better system for searching for active cases and it came up with similar conclusions(2).

This data directly influenced policy which led to the development of the H.Influenza vaccine and later the pneumococcal vaccine which led to a significant decline in the incidence of bacterial meningitis as concluded by the 2003 CDC surveillance report(2). H. Influenza infection declined by 94% and as a result S.pneumoniae became the leading cause of bacterial meningitis (47%) followed by N.meningitidis (25%) and L.monocytogenes (8%)(2).

The use of vaccines has also led to the increase in the median age of infection. This has been attributed to the decrease in Haemophilus Influenza which made up bulk of the infection(2).

In Africa, an enhanced meningitis surveillance network was also set up to collect data prospectively in 10 countries over the period of 10 years. The surveillance showed that the case fatality ranged from 10-13% with seasonal peak notes over the first 5 months of the year. Of the positive CSF samples 36% were positive for Neisseria and 8% for S. pneumoniae and

4%for H. Influenza. However, with the introduction of meningococcal vaccine, the incidence of N. meningitis fell by 10 fold.

This study was conducted in the meningitic belt an area prone to N. meningitides outbreak. Kenya despite being a country with an increased incidence of bacterial meningitis was not included in this surveillance.

The HIV epidemic has drastically changed the spectrum of CNS disease in Sub-Sahara Africa. Though Strep. Pneumonia and N. meningitides still remain important causes of adult meningitis, cryptococcal and tuberculous meningitis have now become the most common causes of meningitis among HIV patients in Africa, and are easily being diagnosed and treated as an acute bacterial meningitis(1).

This is because accurate diagnosis of meningitis is difficult and thus most of the treatment of suspected meningitis is based mainly on clinical features and due to the recurrent epidemic of meningococcal meningitis most patients are started on empirical therapy taking into consideration other causes of meningitis only after a failed antibiotic trial(1).

Kenya was not among the countries that took part in the meningitis surveillance. Most documented data regarding epidemiology of ABM is restricted to the pediatric population.

A surveillance study was done prospectively at an urban hospital over a period of one year where they analyzed the CSF samples via culture and PCR. The prevalence of ABM was noted to be 11% with 55% being caused by S. pneumonia, 32% by N. meningitis and 14% by H. Influenza(3). This study was carried out among children under the 5 years of age. A similar study done in Kilifi reported a prevalence of 6% of bacterial meningitis in all hospital admissions(4). Another study conducted in a large teaching and referral hospital among the pediatric age group assessed hearing loss among patients being managed for bacterial meningitis reported 20% of confirmed cases of bacterial meningitis were caused by S. pneumonia(5). Most of these studies were carried out at one site and thus results are not generalizable to the whole country. We also did not manage to get information about the prevalence of bacterial meningitis among our adult population.

## 1.2 PROBLEM STATEMENT

The incidence of ABM still remains higher in sub Saharan countries compared to the Western countries(6) this could be attributed partially to the higher prevalence of HIV in these countries. The countries also lying in the equatorial belt Kenya included, have a higher incidence of meningococcal meningitis (Meningitis belt). In low income countries, like Kenya, with the high prevalence of HIV in those countries, there is a 50% chance of mortality(7) however, despite the high morbidity and mortality, Kenya has scanty data on the prevalence of bacterial meningitis in the adult population. No audits have been done to assess the gaps in management of ABM in Kenya. Kenya is also yet to establish standards to guide in the management of acute bacterial meningitis in adults.

# CHAPTER TWO: LITERATURE REVIEW

## 2.1 PATHOGENESIS

ABM develops when host defense mechanisms are overpowered by the various virulence factors of the pathogen. There are four main steps that a person goes through before developing active disease. These include: colonization, entry into the bloodstream, immune evasion in the bloodstream and penetration of the blood brain barrier.

### 2.1.1: Colonization

Pathogens that cause ABM initially colonize the upper respiratory tract. The process of colonization involves adhering of the pathogen to the cell surfaces and evasion of the host's defense system. The organisms attach to the epithelium via the fimbriae, for example the type 4 pili (tfp) in Neiserria Meningitides, which adhere to various receptors in the epithelium. The maintainance of the adhesion is the function of the opacity proteins (OpC and OpA).

### 2.1.2: Bloodstream Invasion

Entry of the pathogen into the bloodstream occurs either pericellularly or transcellularly. Meningococci are transported via phagocytic vacuoles across the epithelial cells while pneumococcal utilizes both transcellular and pericellular mechanisms via epithelial receptors.

### 2.1.2: Survival in the bloodstream

After entering the bloodstream, the pathogen evades immune mechanisms via the bacterial capsular polysaccharide which, prevents binding of factor B to C3b thus preventing subsequent activation of the alternative pathway through its capsular sialic acid.

### 2.1.3 Meningeal Invasion

The exact entry point of the pathogen into the CSF is not known. The inflammatory process that ensues when the pathogen get into the CNS leads to the disruption of the blood brain barrier (BBB). This causes the pathogens to cross the blood-brain barrier either transcellularly within the infected phagocytes, paracellularly or a combination of both routes. Majority of the cases of meningitis occur via hematogenous spread of the pathogen with exception of S.pneumoniae meningitis which mostly occurs through direct invasion of the CNS.

The subarachnoid space lacks a proper defense mechanism. This allows bacteria to multiply there with minimal immune response the pathogen components are then recognized by the microglia cells via the pattern recognition receptors (PRP) which triggers a cascade of pro-

inflammatory events leading to the release of interleukin 6, interleukin 1β and TNF-α. This immune response is more severe for S. pneumoniae than the other pathogens giving it a worse prognosis compared to the rest of the pathogens. Bacterial lysis either through antibiotic response or autolysis augments the inflammatory process(8).

**2.2: DIAGNOSIS**

Considering many illnesses present with similar symptoms, the clinical diagnosis of ABM can be difficult. The main features of ABM including neck stiffness, fever, altered consciousness and headache occurs in less than 50% of patients diagnosed with ABM (9). Any two of the four cardinal signs were found in 95% of patients diagnosed with ABM. The usefulness of Kerning's and Brudzinski's(9) signs in clinical assessment has been cast into doubt due to their high dependence on the clinicians' skills as well as its low sensitivity (5%)(10).

CSF analysis is vital in making the diagnosis of ABM. The components of the CSF analysis include measuring the opening pressures (often high in ABM); the CSF cell count (WBC usually high); CSF biochemistry which includes lactate levels, glucose and protein levels. The CSF glucose are dependent on the serum glucose levels measured simultaneously. CSF lactate is advantageous over the glucose as it does not require a serum lactate level for comparison. Furthermore, it has a high sensitivity (96%) and a high specificity (96%) in differentiating bacterial from viral meningitis(10).

CSF gram stain and culture help in identifying the causative pathogen and determining the various antibiotic susceptibilities. However, if a LP is done after antibiotics are given the sensitivity of the culture reduces to approximately 44%(11). This has led to the use of molecular methods such as the polymerase chain reaction (PCR), which can detect organisms days after antibiotic has been given both in the blood and in the CSF with a high sensitivity and specificity (11). Blood cultures can also be useful in identifying causative organism but the sample should be taken before the antibiotics are started.

There has been debate on when to do neuro-imaging tests for patients suspected to have ABM especially before lumbar puncture with some groups recommending that the imaging to be done before lumbar puncture (LP) for all patients while another group recommending neuro-imaging to be deferred unless there is an immediate contraindication for a LP. The former, approach has been associated with delays in initiation of treatment, reduced sensitivity of tests

and an increase in mortality(12). The main purpose of the neuro-imaging is to exclude any cerebral herniation syndromes, or shift of brain compartments which if present and a LP is done, could lead to fatal herniation.

There has also been a debate on the exact level of consciousness at which it's safe to perform LPs with different authorities recommending cutoff points ranging between 8 and 13 on the Glasgow coma scale (11)(13) . A retrospective study carried out by Glimarker (2015) concluded that performing a prompt LP in patients with impaired mental status without waiting for the neuro-imaging was associated with significantly earlier treatment and a favorable outcome(14).

**2.3: TREATMENT**

Treatment with antibiotics should be initiated as fast as possible to any patient with suspected bacterial meningitis however, both blood and CSF should have been obtained for culture before initiating treatment. Early initiation of treatment is associated with a lower mortality(14). Penicillin and other β-lactams have been shown to be effective against the commonest pathogens with a high CSF concentration even with uninflamed meninges(14). However, with the emergence of antimicrobial resistance, (mostly against S. pneumoniae), the choice of empirical treatment in many countries has been affected. For example, according to a report released by the WHO in 2014, penicillin-resistant pneumococci have been reported from all parts of the world and have been associated with increase in mortality (14). Those patients with this type of resistance are treated empirically with vancomycin, however due to its inability to cross the blood brain barrier well, it should be used in conjunction with another antimicrobial mostly cephalosporins.

There has been debates on how long to give antibiotics this is due to the limited trial evidence available. In children short courses of antibiotics (4-7 days) was shown to be as equally effective as a two-week treatment (15). However, due to lack of randomized trials, current guidelines are based on guidelines from various authorities which recommend giving short courses of antibiotics for meningococcal disease (5–7 days); 10-14 days for pneumococcal meningitis and at least 21 days for Listeria meningitis(16).

The mortality in ABM is around 30% in developed countries and around 50% in the developing countries despite the presence of a susceptible organisms and appropriate

medication (17)(18). This has been attributed to the inflammatory process. This has led to various efforts in trying to identify add on treatments that might help in reducing the inflammatory process.

A study done in Europe showed that dexamethasone had a significant impact in reducing unfavorable outcomes of patients with ABM especially among patients with pneumococcal meningitis however when a similar study was carried out in Malawi it did not produce similar results (19)(20). A follow up study did not attribute any of the differences to the high rates of HIV or tuberculosis in the sub-Saharan countries(21).

The dose of corticosteroids given varied between trials, with the dose being given with or just before the first antibiotic dose(10).

**2.4: OUTCOME**

The mortality rate of ABM has reduced remarkably in the Western countries from approximately 45% to approximately 11% over the last 50 years. This has been attributed to widespread use of penicillin as well as early initiation of treatment and marked improvement in the supportive care measures(22).

This however, has not been the case in sub Saharan Africa where the mortality rate has remained unchanged over time (54-70%) with higher rates of neurological complications over time(20)(23)(24). In Western countries, factors associated with poor prognosis are: elderly population, episodes of acute hyperglycemia and immunosuppressed state (25)(26).

A study carried out in Malawi in 2013 assessing the mortality of patients being managed for bacterial meningitis showed that 45.3% of the patients had died by day 10 and 54.3% by day 40. Most of these patients had an altered mental state with a median GCS of 12(3). 59% of the patients had a positive CSF culture with 85% having Streptococcus pneumoniae as the isolate. CSF opening pressures were rarely recorded(7) (3).

There was a significant difference in the outcome of patients in relation to the duration they took to be reviewed with the median time of review for survivors being 1 hour as compared to the non survivors which was around 3 hours(7) (3)

A similar study carried out in Ethiopia(1) (31) showed that of the 127 patients treated, only 70% met the clinical and laboratory criteria of ABM. LPs were performed on 95% of the

patients. Of those, only 47.1% of the specimens were collected before the first dose of antibiotics and CSF was purulent in 34.1% of the specimen collected. (1).

The overall mortality was 22.3% and 33% had unfavorable outcomes. On multi variant analysis, fever by second day post admission and a low GCS score were associated with a poor outcome(1).

**2.5: AUDITS**

According to the oxford dictionary, the word “audit” is a Latin word that indicates both active listening and the action of investigation and interrogation of the judiciary. When used in English vocabulary “audit” is used to mean “an official inspection of an organization’s accounts, typically by an independent body”.

Nowadays, this term has been used to refer to procedures that are used to ensure that the activities carried out for a purpose are in line for the achievement of certain goals and objectives.

For effective quality improvement processes that focus on specific issues in regards to health care, clinical audits are of vital importance. The main purpose of doing an audit is to highlight the differences between actual practice and standard in order to identify the changes needed to improve the quality of care. Audit characteristics include: 1) the clinical capability of the participants, 2) ability to ensure that the results remain confidential, 3) the object must be strongly connected to the “capability” of professionals. For the methodology, a "quality loop" is used in audits (figure 1) where the topic is chosen and compared to set standards. The objective of a clinical audit is to always improve the standards of care offered to the patients. This can be achieved through different actions: (1) It can increase the culture of clinicians; (2) It can help solve a problem; (3) It can help standardize the professional conduct; and (4) It can help minimize the gap between set standards and real life.

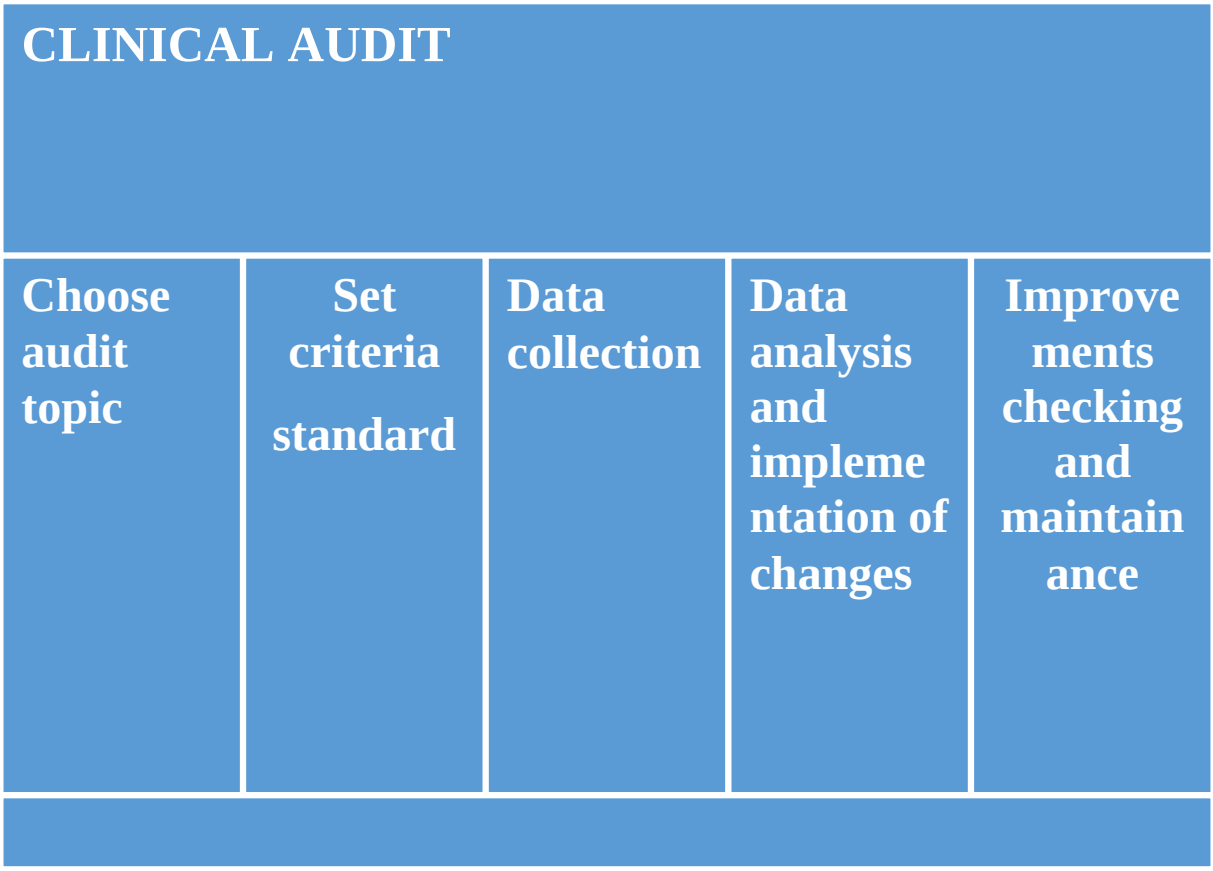


**Figure 1: Clinical Audit**

### 2.6: MENINGITIS GUIDELINES

#### 2.6.1: Clinical Features

Over the years, there have been various guidelines in acute bacterial meningitis management. According to the European federation on the Neurological society (EFNS) (13), the presence of two of the four cardinal signs that is: headache, neck stiffness, altered mental status and fever was enough to suspect acute bacterial meningitis (ABM). The UK joint specialist societies recommended the same, however the UK specialists' guideline added that Kerning's and Brudzinki sign are not useful when making a diagnosis (27). The South African guidelines had the same description of the clinical features however, they limited acute illness to less than seven days (28).

### 2.6.2: Hospital care

The EFNS guidelines recommends that patients should be admitted within 90 minutes of first contact with the health care facility; and initiated on treatment at least within 60 min after hospital admission, and not exceeding 3 hours after contact with health service.

The UK joint specialists advocate that the patients should be reviewed within 14 hours of visiting the hospital however, the clinicians are required to use the National Early warning score (NEWS) to stratify the risk. The parameters used in NEWS include: heart rate, temperature, respiratory rate, oxygen saturation, systolic blood pressure and level of consciousness. A score greater than five is an indicator for prompt assessment by the clinicians. Glasgow coma scale should also be recorded as part of the first assessment for both prognostic value and monitoring of progress. Blood cultures are recommended to be done within one hour of presentation to the hospital prior to prompt antibiotic administration.

### 2.6.3 Diagnosis

All three guidelines recommend lumbar puncture and blood cultures to be done within one hour of reporting to the hospital. However, there are various neurological contraindications for lumbar puncture for example, unexplained new focal neurological deficit. In these cases, neuro-imaging is recommended first and antibiotics given immediately after a blood culture is done.

Some of the absolute contraindications of a LP include: 1) significant brain shift on imaging, 2) An alternative diagnosis is established, 3) continued seizures, 4) rapidly deteriorating GCS 5) cardiac/respiratory compromise 6) Signs of severe sepsis or a rapidly evolving rash 7) Infection at the site of the LP 8) Coagulopathy

The guidelines however differ on the GCS at which a lumbar puncture is contraindicated. The EFNS guidelines recommend that the LPs to be contraindicated in patients with GCS less than 8. The UK specialists' guidelines recommend GCS of less than 12 with the South African guidelines lying in between the two contraindicating LPs in patients with GCS of 10. The South African guidelines also include HIV serology tests as one of initial tests.

The CSF studies in the three guidelines include opening pressures, CSF gram stain and culture and CSF biochemistry.

### 2.6.4: Antibiotic Choice

All the three guidelines agree that the initial antibiotics should be parental with ceftriaxone 2 grams twice daily or cefotaxime 2g 6-8 hourly as the first choice of treatment. However, the alternative therapies vary. The EFNS guidelines advocate for the use of Meropenem 2 grams 8 hourly or Chloramphenical 1g 6 hourly. The South African guidelines advocate for the use of acyclovir in addition to the antibiotics especially in patients with fevers and altered mental status. They also state that if the blood culture and CSF culture is negative and the patient has clinical improvement in 48-72 hours then the patient most likely has bacterial meningitis. A repeat LP is necessary if no clinical improvement is noted.

### 2.6.5 Duration of Treatment

For the duration of EFNS and South African guidelines recommended the following:

- For patients with unspecified bacterial meningitis (that is no organism was isolated on culture) and Pneumococcal meningitis as per culture results treatment should be given for a minimum of 10 days
- For patients with Meningococcal meningitis duration of treatment is a minimum 5 days
- H. Influenza meningitis is usually treated for a minimum of 7 days
- Listerial meningitis is treated for a longer duration usually a minimum of 21 days
- Gram-negative bacillary and Pseudomonal meningitis are usually treated for 21–28 days. The UK specialists advocate for 5-day regimen for meningococcal meningitis and 14-day protocol for pneumococcal meningitis.

### 2.6.6: Previous audits

Cullen (2005) conducted a nine-month retrospective study at a local hospital in Manchester. He audited the hospital against the British Infectious Association guidelines that were published in 1999. He found out that whereas the general investigations were carried out promptly, the specific investigations for meningitis were frequently missed. He stated that most patients were started on the right treatment as per the guideline however, the dosage varied greatly (29). His study was carried out over a 9-month period and his sample size was 68 patients.

In 2010, a large five-year retrospective audit was conducted at the Addenbrook hospital in England (30). It evaluated the hospital against British Infectious Association guidelines 2004. The four cardinal signs were only present in 21% of cases. Lumbar puncture was contraindicated in 69% of cases however, in those not contraindicated only 17% had an immediate lumbar puncture done. The median duration of initiating treatment was 79 minutes with 65% of the cases receiving treatment within 3 hours. 85% of the patients received the right treatment at the appropriate dosage and duration of time as per the guidelines(30).

A retrospective study was done in Lebanon over a 6-year period from January 2008 to December 2016 in five large hospitals. The study compared the management of ABM in Lebanon against the IDSA American guidelines on management of ABM. The study found that 68.7% of the patients enrolled were inappropriately treated for ABM with 42.5% of incompatibility being as a result of the wrong drug of choice, 31.7% being a result of inadequate dosage and 25.4% being due to inappropriate route of administration(31)

**2.7 STUDY JUSTIFICATION**

Bacterial meningitis is a common cause of mortality causing around 135,000 deaths annually worldwide(2) and causing neurological sequel in around 21% of patients (32). In low income countries, with the high prevalence of HIV in those countries, the is a 50% chance of mortality(7). Some of the other reasons for this high mortality include delayed presentation and treatment initiation with limited diagnostic facility and poor standards of care(33), (34). Despite this, the country is yet to develop a standard guide on the management of adult bacterial meningitis.

The aim of this study was to highlight the various practices (diagnostic and treatment practices) in the management of ABM evaluating them against the UK specialist guidelines 2016. This guideline was chosen as we are yet to develop our own guidelines on management of suspected bacterial meningitis in adults.

This study helped us to: 1) identify some of the gaps in the management of ABM ;2) generate data that can be used to develop guidelines for the future; 3) standardize the quality of care for patients being managed for bacterial meningitis

## 2.8: STUDY SIGNIFICANCE

This study helped us highlight some of the gaps in the management of ABM and will help us standardize treatment of ABM and develop data that will help us create guidelines for the management of ABM in the two hospitals and at national level.

## 2.9 CONCEPTUAL FRAMEWORK

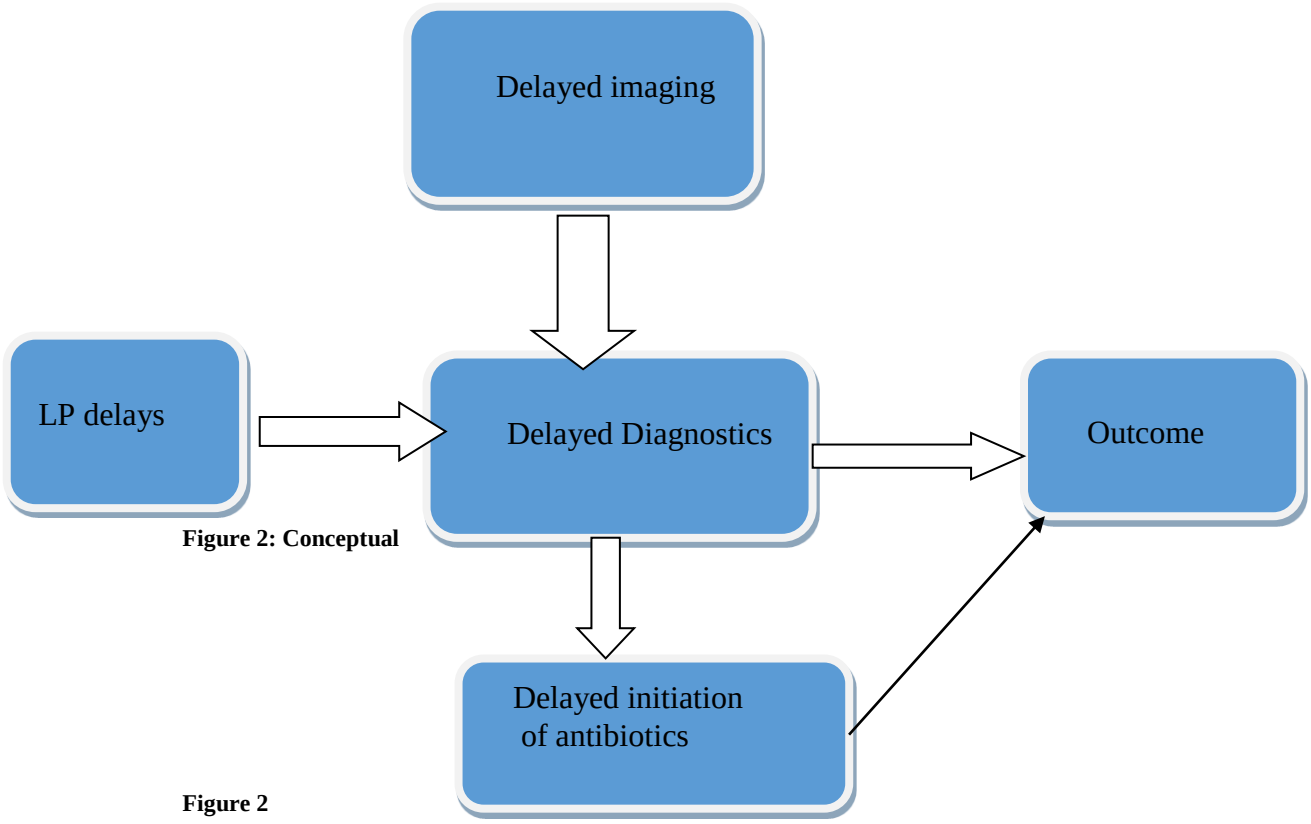


**Figure 2: Conceptual**

**Figure 2**

## 2.10 RESEARCH QUESTION

What are the practices in the diagnosis and management of suspected bacterial meningitis in two hospitals in Nairobi?

## 2.11 RESEARCH OBJECTIVES

- To document the diagnostic criteria of patients on management for suspected bacterial meningitis in two hospitals in Nairobi as compared to the UK specialist guideline 2016.
- To document the timing, duration and dosage of antibiotics given to patients managed for bacterial meningitis in two hospitals in Nairobi as compared to the UK specialist guidelines 2016.

# CHAPTER THREE

## 3.0STUDY DESIGN AND METHODOLOGY

### 3.1: Study Design

The study was a prospective descriptive study.

### 3.2: Study site

The study site was The Kenyatta National Hospital (KNH) and Mbagathi county hospital. KNH is a national referral hospital in Nairobi, the capital city of Kenya. It has a bed capacity of over 1800. The main catchment areas are Nairobi, Central and surrounding Eastern parts of Kenya. KNH is also a teaching institution for both undergraduate and postgraduate medical students and various other disciplines in health**.** The main areas of the study will be all the medical wards on the seventh and eighth floor except the oncology ward 8C and the Dermatology ward 7C. Mbagathi county hospital is found in the heart of Nairobi. It has a bed capacity of around 300 patients. It also acts as a teaching center for both undergraduate and postgraduate students. Its main catchment area is the Nairobi county. The main area of study were male and female medical wards.

### 3.3: Study population

The study population was patients admitted with the diagnosis of suspected bacterial meningitis in the medical wards in KNH and at Mbagathi hospital.

### 3.4: Case definition

These are patients who have any two of the following features: neck stiffness, altered level of consciousness, headache and fever admitted in the medical wards as well as patients on anti-meningitic doses of antibiotics.

### 3.5: Sample size

Sample size will be calculated using the (Daniel, 1999) formula;

$$n = \frac{Z^2 x\ P(1-P)}{d^2}$$

Where,

$n$ = Desired sample size

$Z$ = value from standard normal distribution corresponding to desired confidence level (Z=1.96 for 95% CI)

$P$ = expected true proportion (estimated from a retrospective study conducted by Sahar et al (2019) over a period of eight years in five hospitals in Lebanon where 30.7% received treatment regimen incompatible with the guidelines. This study was chosen as it was carried out in a developing country in multiple hospitals within Lebanon(35).

$d$ = desired precision (0.05)

$$n_0 = \frac{1.96^2 x\ 0.31(1-0.31)}{0.05^2} = 328$$

Currently in Kenyatta national hospital approximately 7 patients are admitted with suspected bacterial meningitis per week. This amounts to approximately 28 patients per month. In Mbagathi around 10 patients are managed for suspected bacterial meningitis per week which amounts to around 40 patients per month which totals to around 80 patients over the study period. Adjusting the sample size for finite populations less than 10,000

$$nf = \frac{n_0}{1 + \frac{n_0 - 1}{N}} = \frac{328}{1 + \frac{328 - 1}{80}} = 64$$

A Sample size of 64 patients was used over the study period of one month. The population was higher in Mbagathi as compared to KNH therefore the population was sampled in a ratio of 2:1. 42 patients were sampled from Mbagathi and 21 patients from KNH.

**3.6: Sampling Method**

The sampling method used was consecutive sampling till the appropriate sample size was attained.

**3.7: Procedure/Data collection**

The first day involved going through the files of patients with suspected bacterial meningitis admitted in the six medical wards. The PI checked the time of arrival of the patient in the A/E as noted on the casualty report at the back of the file and the time of admission in the ward as noted in the nursing notes.

The PI also noted the various diagnostic tests done on day 1 of admission as well as the time of antibiotic initiation and the appropriateness of the treatment by visiting the post admission

ward and assessing the dosage, duration and type of antibiotic given as recorded in the treatment sheet. Further assessment of the files was done on day 7 noting the outcome of the diagnostic tests and assessing if the tests influenced a change in management. The files were also assessed on day 14 where the duration of antibiotics was noted and the outcome of the patient documented (i.e. discharged home or dead). Among the patients selected, the information was obtained purely from the patients' records. The patients were not required to provide any additional information.

**3.8: Study entry point**

All files of patients admitted to the medical wards usually (13 years and above) diagnosed with suspected bacterial meningitis.

**3.9: Inclusion criteria**

Patients files were included if they were admitted in the medical wards having any two of the following features: neck stiffness, altered level of consciousness, headache and fever. The patients were also included if they are on anti-meningitic doses of antibiotics.

**3.10 Exclusion criteria**

Patients were excluded if:

- They were on management of cryptococcal meningitis and did not have anti-meningitic dosage of antibiotics on their treatment sheet
- They were on management for TB meningitis and did not have anti-meningitic dosage of antibiotics on their treatment sheet

**3.11: Audit guidelines**

Audit guidelines for this study was primarily based on the UK joint specialist society's guideline on the diagnosis and management of ABM 2016. For target timing of antibiotics from first point of contact with a healthcare facility, the EFNS guidelines was used (180 minutes) as the UK guidelines do not specify on the target time. Due to the fact that the study was carried in an area with a heavy HIV burden, HIV serology tests were included in the audit in line with the South African guidelines.

These guidelines were chosen as we are yet to develop Kenyan guidelines on ABM in the adult population and the KNH treatment guidelines did not include treatment guidelines for acute bacterial meningitis

The outcome variables for the audit are:

- LP was performed prior to initiation of treatment unless there were contraindications
- LP opening pressures and CSF studies were well documented in the file
- LP was appropriately deferred until stabilization and/or CT head scan if signs of raised intra-cranial pressure, shock or respiratory failure were present.
- Blood cultures were taken prior to the administration of antibiotics.
- Target timing of antibiotics was within 180 min of arrival.
- The choice and dose of antibiotic was appropriate and complied with the guidelines
- The duration of therapy

## FLOW CHART OF THE STUDY

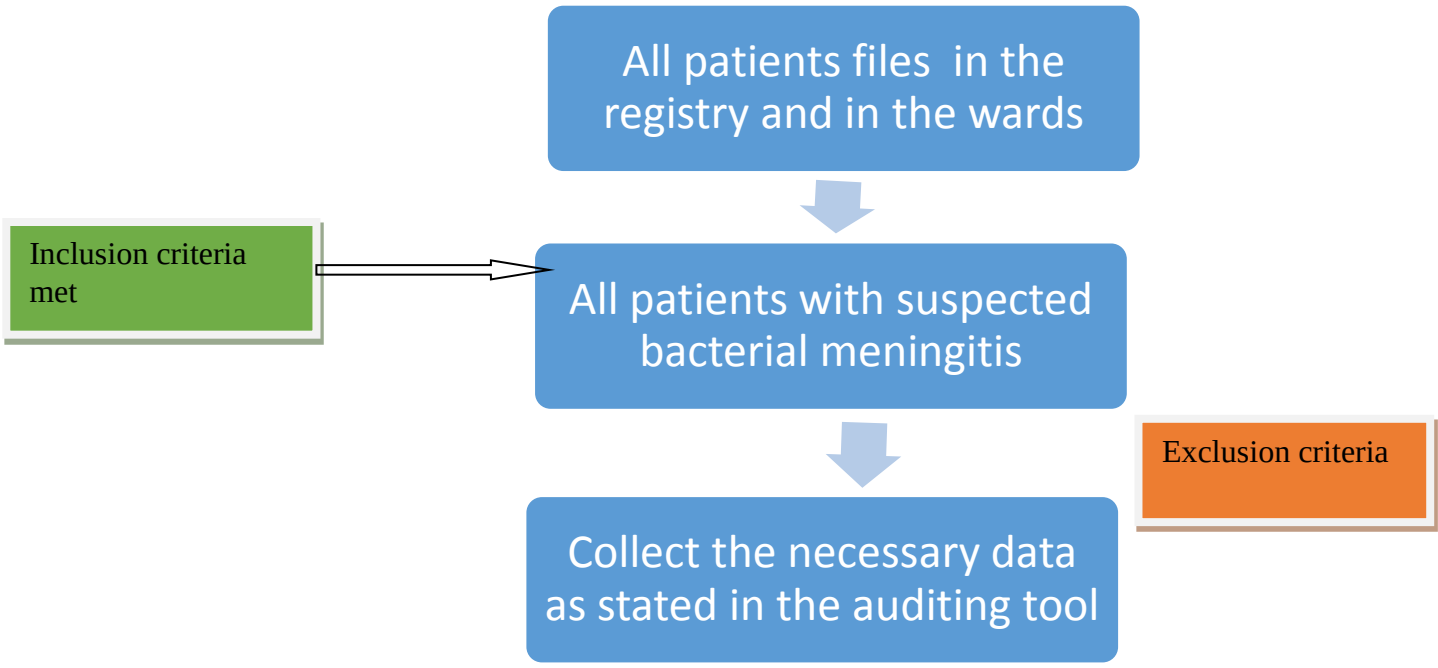


**Figure 3: Study flow chart**

### 3.8: Study Instruments

- A study profoma was used to collect socio-demographic and clinical data e.g. sex, age, employment status, marital status, level of education and duration of illness.10Wi Meningococcal Auditing tool 2016 (**APPENDIX 1)** was used as the auditing tool.

### 3.9 Quality Assurance

The 10Wi meningococcal auditing tool was used in the creation of the UK specialist meningitis guidelines 2016. This audit tool was used to assist retrieve the data needed to compare the clinical practices against the UK specialist guidelines. The tools were also very user friendly and easy to fill minimizes errors.

One study assistant was recruited for the study. The study assistant was required to have a minimum of a diploma in the medical field and should have worked or rotated in at least one of the two hospitals. The study assistant was adequately trained by the PI on the data collection process prior to the onset of the data collection thus the assistant was well vast with the research tools and all clarifications were made beforehand. This was done to minimize errors during the data collection process hence reliable data. Data verification was done by the PI at the end of each data collection day.

### 3.10: Ethical Consideration

Approval was obtained from the department of clinical medicine and therapeutics of the University of Nairobi and KNH research and ethics committee before commencement of data collection. Patients' confidentiality was maintained by assigning codes to the data collection forms and computerized data. Data collection forms were stored in a lockable case that were accessible only to the principal investigator.

The sole purpose of the data collected was to meet the objectives of this study.

### 3.11DATA MANAGEMENT AND ANALYSIS

All data from the study proforma was coded, entered and managed in Microsoft access database. Data cleaning was conducted at the conclusion of data entry. Data analysis was done using the SPSS Chicago Illinois version 21. Study population was defined using clinical and socio-demographic characteristics. Continuous variables were summarized as mean and

standard deviation while categorical variables e.g. age and sex were presented as proportions. Duration before start of treatment, duration of treatment and duration before the lumbar puncture is done were analyzed using the inter-quartile ranges. The proportion of files with the relevant results was represented by histograms for the numeric data while the categorical data was represented by bar graphs.

### 3.12 STUDY FEASIBILITY

Around 2 patients are admitted in the medical wards per day with a diagnosis of suspected bacterial meningitis. This totaled to around 60 patients over the 1-month study period. The PI and his assistant visited the admitting wards on a daily basis to identify patients for the study. The PI financed the entire study.

### 3.13: STUDY DURATION

The study period for this study was from December 2019 to February 2020.

## CHAPTER FOUR: RESULTS

Between December 2019 and February 2020, we recruited 70 study participants. Six patients excluded were only on cryptococcal meningitis management and 1 patient who was on anti-TBs only for management of TB meningitis. All of these patients were excluded from KNH.

**STUDY FLOW CHART**

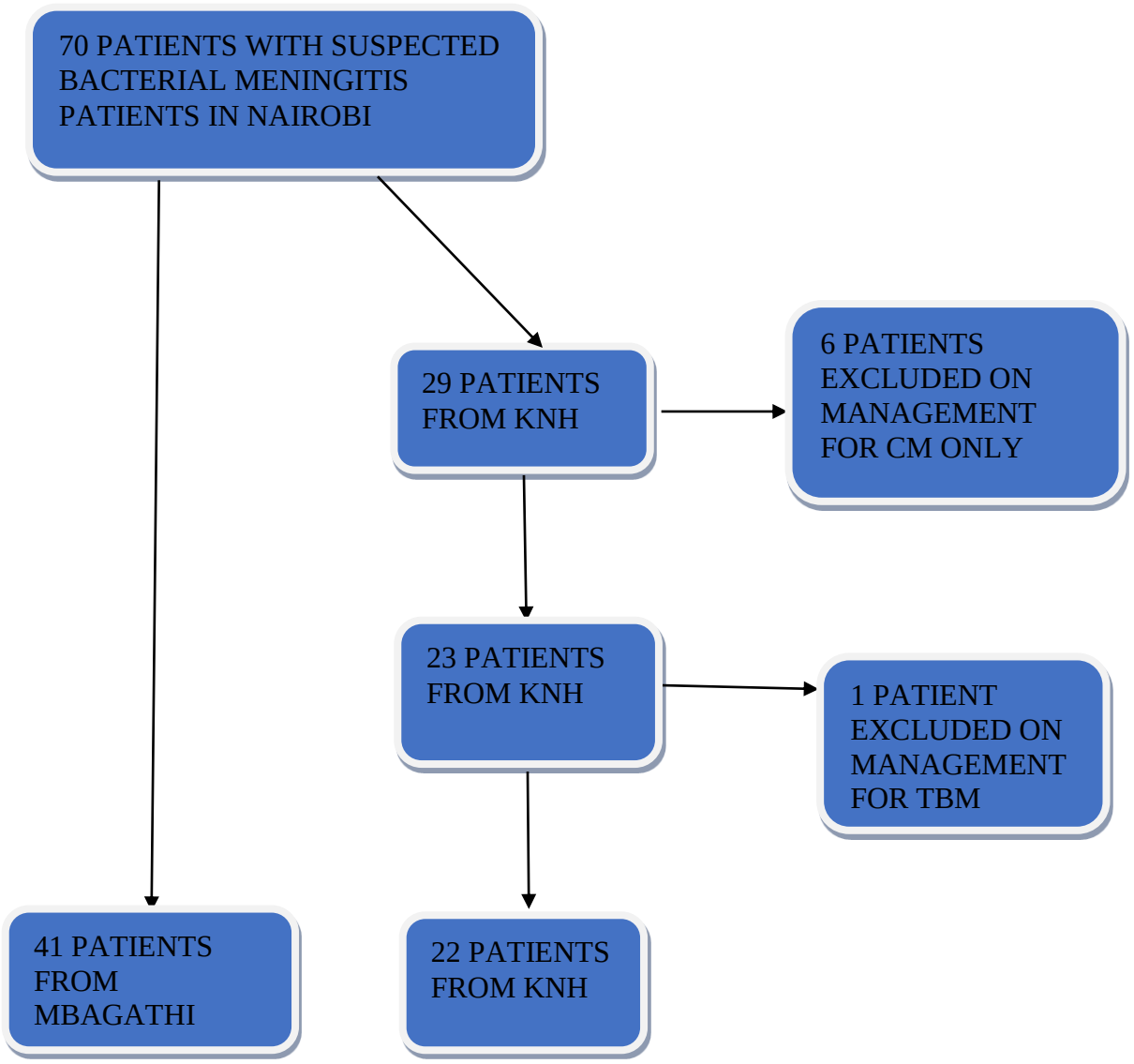


**Figure 4: Study flow chart of patients with suspected bacterial meningitis**

### 4.1: NUMBER OF PARTICIPANTS IN EACH HOSPITAL

In this study,22 participants were from KNH while 41 of our study participants were from Mbagathi District hospital. KNH had less study participants as it had fewer patients admitted with bacterial meningitis over the study period compared to Mbagathi which had a patient admitted with bacterial meningitis on a daily basis.

### 4.2: SOCIAL DEMOGRAPHIC CHARACTERISTICS OF STUDY PARTICIPANTS

The study participants were relatively young patients with a median age of 35 years with a minimum age of 17 years and a maximum age of 67 years. Majority of the participants from KNH were male (58.7%) while 41.3% were female.

**Study Participants (N=63)**

| CHARACTERISTICS | FREQUENCY | PERCENTAGE |
|---|---|---|
| Center name | | |
| KNH | 22 | 34.9 |
| Mbagathi | 41 | 65.1 |
| Age | | |
| Mean | 37.63 years | |
| Median | 35.00 years | |
| Min-Max | 17-67 years | |
| Gender | | |
| Male | 37 | 58.7% |
| Female | 26 | 41.3% |

**Table 1: Demographic characteristics of the study participants**

## 4.3: CLINICAL CHARACTERISTICS OF STUDY PARTICIPANTS

**Study participants (N=63)**

| CHARACTERISTICS | FREQUENCY | PERCENTAGE |
|---|---|---|
| **PRESENTING COMPLAINTS** | | |
| Headache | 37 | 58.7% |
| Seizures | 6 | 9.5% |
| Altered level of consciousness | 19 | 30.2% |
| Focal body weakness | 1 | 1.6% |
| **HIV SERO STATUS** | | |
| Positive | 40 | 63.5% |
| Negative | 18 | 28.6% |
| Not done | 5 | 7.9% |

**Table 2: Clinical features of study participants**

### 4.3.1: TEMPERATURE

Of the study participants,38.1% were afebrile while 11.1% were febrile. However, majority of the patients (50.8%) did not have their temperature recorded. Of the participants whose temperatures' were not recorded, 73.1% were from Mbagathi.

### 4.3.2: Neck Rigidity

Most of the study participants (63.6%) in KNH had neck rigidity compared with 73.2% of participants in Mbagathi with a cumulative percentage of 69.8%. Only one participant (4.5%) from KNH did not have any data on neck tonicity compared to 2 participants (4.9%) from Mbagathi.

### 4.3.3: Presenting complaints

Headache was the major presenting complaint in both facilities (Mbagathi 65.9%, KNH 45.5%) Seizures were more common in Mbagathi (22.7%) than KNH (2.4%). Only one participant had focal body weakness from Mbagathi.

### 4.3.4: HIV-status

Majority of the participants in Mbagathi were HIV positive(80.5% ) while, in KNH only 31.8% were HIV positive. Three participants (13.6%) in KNH and 2 participants (4.9%) in Mbagathi didn't have their sero-status recorded.

## 4.4: DIAGNOSTIC TESTS CARRIED OUT AMONG STUDY PARTICIPANTS
**Study participants (N=63)**

| DIAGNOSTIC TEST | KNH | MBAGATHI | TOTAL |
|---|---|---|---|
| **LPs Done** | **17 ( 77.2%)** | **28 (68.3%)** | **71%** |
| **Median LP time** | **2 days** | **3 days** | **3 days** |
| **CSF culture** | **18 (81.8%)** | **11 (27.5%)** | **46.8%** |
| **Opening pressures** | **1 (4.5%)** | **3(7.3%)** | **6.3%** |
| **CSF biochemistry** | **18(81.8%)** | **21 (51.2%)** | **61.9%** |
| **CSF cell count** | **18 (81.8%)** | **15(36.6%)** | **52.4%** |
| **Paired glucose** | **0 (0%)** | **0 (0%)** | **0%** |

**Table 3: Diagnostic test done on the study participants**

### 4.4.1: Timing of CT scan Head

Most of the study participants in KNH (77.2%) had a lumbar puncture done on them while in Mbagathi, 68.3% got the LP done. Most of these LPs were done after the CT scan head (56%). The main clinical reason documented for performing the CT first was seizures (15.9%). In 69.8% of the patients who had the CT scan done before the LP no certain reason was documented.

| REASON FOR DELAYED LP | FREQUENCY | PERCENTAGE |
|---|---|---|
| No reason given | 44 | 69.8% |
| Low GCS | 5 | 7.9% |
| Focal neurological signs | 3 | 4.8% |
| Papilledema | 1 | 1.6% |
| Seizures | 10 | 15.9% |

**Table 4: Reasons for Delayed LP**

### 4.4.2 CSF Studies

In both centers, the opening pressures were not done in majority of the participants. In KNH Only 1 participant had their opening pressure taken (4.5%) while in Mbagathi 3 participants had their opening pressure taken (7.3%).

For the CSF biochemistry, 81.8% were done in KNH and 51.2% in Mbagathi. For the CSF culture, 81.6% participants had CSF culture in KNH while only 27.5% were done in Mbagathi.

The median time when LPs were done was day 3 post admission.

| Timing of LP | Duration in days |
|---|---|
| Mean | 3.15 |
| Median | 3.00 |
| Min-Max | 1-7 |

**Table 4: Timing of Lumbar puncture in days**

### 4.5: TREATMENT MODALITIES

**Study participants (N=63)**

| TREATMENT MODALITY | KNH | MBAGATHI | TOTAL |
|---|---|---|---|
| **Right empiric treatment** | **20 (90.9%)** | **32 (78%)** | **82.5%** |
| **Median time of initiation of Rx** | **4 hours** | **2 hours** | **2 hours** |
| **Duration of Rx** | **12 days** | **10 days** | **10 days** |
| **Definitive Rx** | **2** | **0** | **3.17%** |
| **Discharged** | **16 (72.7%)** | **30 (73.2%)** | **73.0%** |
| **Dead** | **6 (27.3%)** | **10 (24.4%)** | **25.4%** |

**Table 5:Treatment modalities and outcomes of the study participants**

Almost all of the participants in KNH with suspected bacterial meningitis had the right empiric drugs given (90%) while in Mbagathi 78% had the right empiric treatment. Median time of initiation of antibiotics in both hospitals was after 2 hours of admission however when analyzed separately the median time of initiation of treatment in KNH was longer at 4 hours while Mbagathi's median time was still 2 hours after admission. The total median duration of treatment in both hospitals was 10 days with KNH study population receiving treatment for a longer time (median duration 12 days).

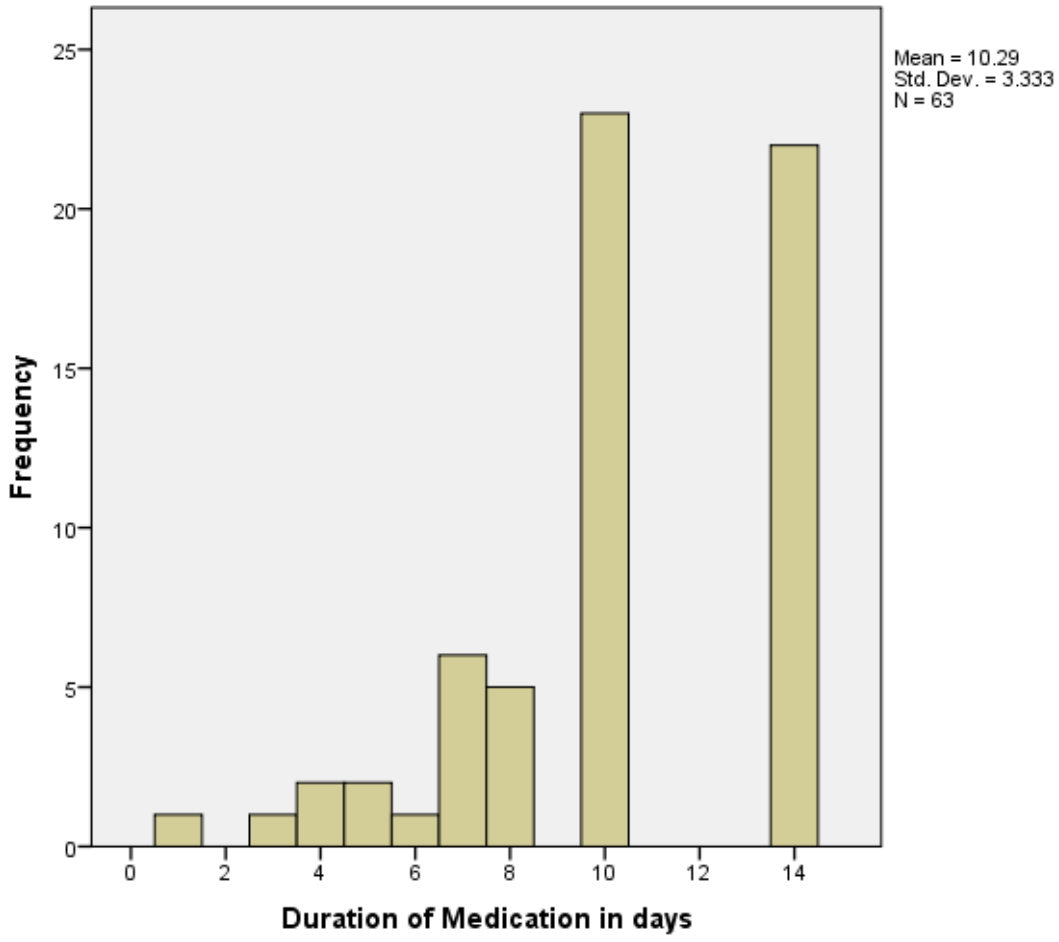


**Figure 5:Total duration of antibiotics**

### 4.6: OUTCOME

Most of the study participants were discharged home (73.0%) while the mortality rate in both hospitals was 25.4%.

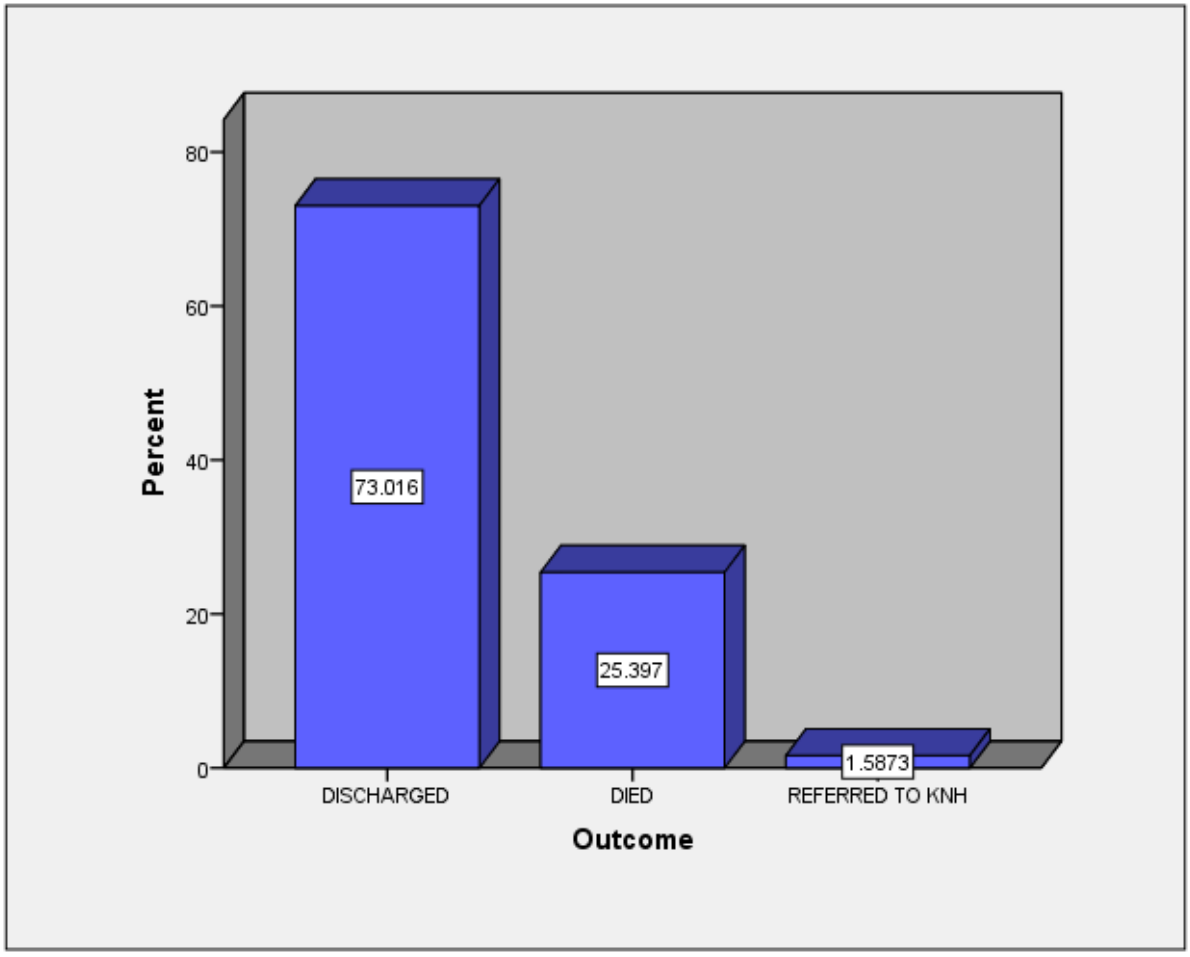


**Figure 6: Outcome of study participants**

## 4.7 COMPLIANCE TO THE UK SPECIALIST GUIDELINES 2016

The total compliance of this study to the UK specialist guidelines was 39.03%. Compliance to the diagnostic criteria was 30.95% while compliance to the treatment protocol was slightly higher at 47.12%.

| COMPLIANCE TO AUDIT GUIDELINES FOR THE DIAGNOSTIC PROCEDURES | | |
|---|---|---|
| **PROCEDURE** | **PERCENTAGE DONE** | **COMPLIANCE TO GUIDELINES** |
| LP done | 71% | 71% |
| Opening pressure | 6.3% | 6.3% |
| CSF Culture done | 46.8% | 46.8% |
| CSF Biochemistry | 61.9% | 61.9% |
| CSF Cell count | 61.9% | 61.9% |
| Timing of LP | | 0% |
| Blood culture done | 0% | 0% |
| Paired glucose level | 0% | 0% |
| **TOTAL COMPLIANCE** | **30.95%** | |

**Table 6:Compliance of the study to the diagnostic criteria of the UK specialist guidelines 2016**

| TREATMENT CRITERIA | COMPLIANCE TO GUIDELINES |
|---|---|
| Right empiric choice of antibiotics | 82.5% |
| Timing of medicine initiation | 38.1% |
| Duration of treatment | 33.1% |
| **Total compliance** | **47.12%** |

**Table 7: Compliance of the study to treatment guidelines of the UK specialist guidelines 2016**

# 5.0: CHAPTER FIVE

## 5.1: DISCUSSION

This is the first audit on the management of acute bacterial meningitis in Kenya among the adult population. This study shows major non conformity to the UK specialist guidelines with only a compliance of 39.03%. This study was done in two hospitals in Nairobi Kenya; that is Mbagathi county hospital and Kenyatta National hospital. The audit needs to be taken in context of the local circumstances.

The study reveals major flows in the management of acute bacterial meningitis. In this study we found that LPs were done in 71% of the patients which was lower than a study carried out in Ethiopia assessing the outcomes of patients having bacterial meningitis, where LPs were performed on 94.4% of their patients, (31) but much higher than a similar study done by Oirere et al (10) at KNH assessing adherence to guidelines among the pediatric population which found that only 35.9% of patients with suspected bacterial meningitis managed to get an LP done despite it being easier to perform an LP in children. Of this LPs in our study, most were delayed with most of them being done after a median of 3 days as compared to the UK specialist guidelines recommended 1 hour. This has a major implication in the accurate diagnosis and management of patients with suspected bacterial meningitis.

The major cause of the LP delay was due to the fact that CT scans were performed prior to undertaking the LP. Some of the reasons why an LP could be deferred as per the UK specialist guidelines were: reported seizures, raised intracranial pressure, focal neurological signs and a deteriorating GCS. In our study, seizures were the main documented reason for the delay in LP (15.9%) however, 69.8% of the patients who did a CT scan had no documented reason for undergoing the procedure before the LP. These findings were quite similar to a five-year retrospective study carried out at Addenbrooke hospital where the main reason for the delay of the LP was neuro –imaging tests especially in patients with low GCS (less than 12) (43). Chadwick et al (7) in a study assessing the impact of new diagnostic methodologies in management of meningitis among the adult population found that 30% of the LPs were delayed by inappropriate CT scans. Michael et al (8) in his study investigating the effects of delayed LP on the diagnosis of suspected bacterial meningitis further showed the inappropriateness of this neuro imaging tests by showing that 20% of the patients who had

CT scans done before LP were not necessary. These unnecessary CT scans lead to delay in initiation of appropriate treatment and increases the financial burden on the patient especially in resource poor settings. Creation of a guideline that clearly illustrates when CT scans should be requested would go a long way in alleviating unnecessary CT scans.

In cases where delaying a LP can't be avoided, blood cultures can be used to identify the micro-organism and initiate the patient on definitive treatment. A study carried out in Denmark(36) showed that blood cultures are important adjuncts to CSF cultures in patients with bacterial meningitis. A number of organisms were isolated from blood cultures in patients with bacterial meningitis despite CSF cultures being negative including rare organisms like Pasteurella mutiocida and Enterococcus faecalis. Samanta et al revealed blood cultures can be effective screening tools with a specificity of 88% and a positive predictive value of 5.97. Majority of blood cultures were also associated with positive CSF cultures however, this study was carried out in the pediatric population(37). Coant et al in a 5 year study done among the pediatric population in a children hospital in Buffalo USA showed that for patients with meningitis, blood culture was able to identify the causative organism in 86% of the patients with Hemophilus influenza being isolated in 94% of the cases where antibiotics had been given prior and 100% of the cases where antibiotics had not been given(38). In our study however, none of the patients had blood cultures done. This coupled with the fact that only 49.3% of the patients had CSF culture done could have contributed to the low number of patients on definitive treatment. There was a huge discrepancy in the numbers of CSF cultures done in KNH (81.8%) and Mbagathi (27.5%). This could be attributed to the fact that Mbagathi does not have any laboratory facilities where the CSF samples can be analyzed. Most of the samples are sent to KNH laboratory or private laboratories that demand payment before services are offered unlike for KNH patients where the samples are analyzed and results given before the payment is made. This coupled with the fact that most of our patients were from a resource poor setting made it very difficult for the doctors to collect CSF samples for culture.

Furthermore, of the CSF cultures done, few had any yield. This is evidenced by Laving et al (2001) in a study on neonates with clinical features of bacterial meningitis where only 4.7%

of the cultures had any growth (22). Etyang in his study also compared CSF inoculation yield versus standard CSF yield and he got an overall yield of 11.4% (20).

One of the reasons highlighted by Etyang for the low yield was prior antibiotic use before specimen collection. In our study, the median time for CSF sample collection was 3 days which is well above the recommended 1 hour by the UK specialist guidelines while the median time of initiation of antibiotics was 2 hours which was still above the guideline recommended hour. This means that most of the patients' CSF specimens were collected after a significant duration of antibiotics. Michael et al (9) showed that chances of positive cultures reduced significantly if LP is performed 4 hours after initiation of antibiotics and no growth was obtained after 8 hours of antibiotic treatment. Solomon et al (25) also added onto this in his study on viral encephalitis where he found that LPs done after antibiotics reduced sensitivity of the culture to about 44%.

Initiation of the right empiric treatment can also have a positive impact on the outcome of patient being managed for suspected bacterial meningitis. In our study 82.5 of the patients received the right empiric treatment which is below the expected 100% as recommended by the guideline however, this was two times better than a similar audit study carried out on pediatric patients at KNH where only 42.2% received the right empiric treatment as per the Ministry of health pediatric guidelines. No reason was given for the low compliance in this study. Ceftriaxone is the preferred empiric treatment of choice as per the guideline. This is due to the world wide increase in penicillin resistance as evidenced by Van Deek et al (2006) especially in Streptococcus penumoniae. Etyang et al however contraindicated this in his study where he found that among 220 samples collected, 96% of them were streptococcal pneumonia isolates which were sensitive to crystalline penicillin and chloramphenicol in a study carried out among the adult population(39). This study showed that among the study population, penicillin and chloramphenicol can still be used as effective empiric therapy. No follow up study has been done to assess the sensitivity of CSF cultures since then and no study has been done to compare the efficacy of ceftriaxone versus penicillin and chloramphenicol among bacterial meningitis patients as empiric therapy.

One possible cause of treatment failure in patients with bacterial meningitis is failure to recognize and treat raised intracranial pressure which causes a reduction in cerebral blood flow leading to ischemia. Monitoring CSF pressures and aggressive management of intracranial pressure is crucial in the survival of meningitis patients (14). In a review of literature, Addy et al deducted that 30% of the deaths in acute bacterial meningitis patients was due to raised intracranial pressures (15). According to Golshani et al, to label a patient definitively as having raised intracranial pressure, a direct invasive sampling method of CSF is necessary and the measurement of the pressures is considered as gold standard. However, not all patients are eligible for spinal taps as a result of space occupying lesions (40). Other than CT scans, fundoscopy and bedside ocular ultrasounds have been shown to be useful in the assessing raised intracranial pressure with both having sensitivity of 100%(40). Fundoscopy in our setting is the other alternative used to CT scan head in assessing raised intracranial pressure. However, its use is usually significantly limited especially in patients who are photophobic, intubated or uncooperative. Fundoscopy also relies on the detection of papilledema which can be delayed and is usually a late presentation in patients with raised intracranial pressure (41). In this study, assessment of the intracranial pressures was via measurement of opening pressures in patients without absolute contraindications for LPs. The opening pressures were only measured in 6.3% of the study population. The low compliance to guidelines could have had an impact on the mortality of the patients.

Overall compliance to standard guidelines can go a long way in reducing mortality in patients suspected to have bacterial meningitis especially in low income countries like Kenya where mortality rates are higher than developed countries. However, with an overall compliance of 39.03% to the UK specialist guidelines 2016, we clearly have to improve our standards in the management of patients suspected to have acute bacterial meningitis. One way to improve this is by developing a local guideline suited to our resource poor setting.

# CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

## 6.1: CONCLUSION

We found that the adherence to the UK specialist guidelines was 39.03%. Adherence to diagnostic assessment was 30.95% and 47.12% to treatment modalities. Our study however could not assess the reason for the treatment delay as it was not powered to do so.

## 6.2: RECOMMENDATIONS

This study recommends the following further studies to explore:

1) Proper documentation of vitals and procedures undertaken on the patients
2) Develop local guidelines on the management of bacterial meningitis among the adult population

## 6.3 STUDY LIMITATIONS

The major setback of this study was the lack of proper documentation in the files. Most of the files especially from Mbagathi lacked proper documentation. This was mitigated by looking multiple records from the nursing cadex, doctors' notes, lab results and the treatment sheets to derive as much data as possible. Lack of noted documentation in these records was deemed not done.

Exact time when the LP was done was also missing in most files. Most files just had the date when the LP was performed however, documentation on the exact time, opening pressure and paired serum glucose were not available. This was mitigated by recording the day when the LP was done in relation to the admission. Opening pressures and paired serum glucose not recorded were deemed not done.

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# APPENDIX 1

| **Section A: Baseline information** | | | **Results** |
|---|---|---|---|
| | | | |
| Centre Name | | | |
| Study number | | | |
| Age (years) | | | |
| Gender | | | M/F |
| Final diagnosis | Bacterial meningitis | Specify which: _____ | Y/N |

| **Section B audit criteria** | | |
|---|---|---|
| **1** | Is the time of arrival at hospital recorded | Y/N |
| | a) If yes what was the time (and date): | DD/MM/YY YY HH:MM |
| 2 | Were blood cultures taken? | Y/N |
| | If yes:<br>a. What date and time were the blood cultures taken? | DD/MM/YY YY HH:MM |
| | b. Were blood cultures taken within 1 hour of arrival? | Y/N |
| 3 | Was an LP performed? | Y/N |
| | If yes:<br>a. What date and time was the LP was performed? | DD/MM/YY YY HH:MM |

| | | |
|---|---|---|
| | b. Was the LP performed within 1 hour of arrival? | Y/N |
| | c. If 3b is yes - Was the LP performed before antibiotics were administered in hospital?<br>d. If 3b is no – were antibiotics given within 1 hour of arrival to hospital? | Y/N<br>Y/N |
| 5 | A) Was neuroimaging performed before LP? | Y/N |
| | i) If yes what was the indication (tick all that apply)?<br>Focal neurological signs ☐<br>Presence of papilloedema ☐<br>Continuous or uncontrolled seizures ☐<br>GCS≤ 12 ☐<br>Other (please specify) _____ ☐<br>No reason documented ☐ | |
| | ii) If imaging was performed, was the LP done afterwards? | Y/N |
| | iii) If no to ai), were any of the following present: | |
| | An alternative diagnosis found<br>Imaging revealed significant brain shift<br>Other (please specify)<br>_____<br>____ | |
| | B) Were there any other clinical contraindications to immediate LP? | Y/N |

| | | | |
|---|---|---|---|
| | If yes, which contraindications were present? | | Y/N |
| | i) Respiratory distress | | Y/N |
| | ii) Infection at LP site | | Y/N |
| | iii) Coagulation disorder | | Y/N |
| | iv) Systemic shock | | Y/N |
| | v) Rapidly evolving rash | | Y/N |
| | vi) Protracted seizures | | Y/N |
| | vii) Rapidly deteriorating GCS | | Y/N |
| | viii) Other (please specify)_____ | | Y/N |
| 6 | Was opening pressure recorded when the LP was performed? | | Y/N |
| 7 | Were the following tests sent? | CSF biochemistry | Y/N |
| | | CSF culture | Y/N |
| | CSF cell count | Paired serum glucose | Y/N |
| 8 | a. What date and time were antibiotics for meningitis/meningococcal sepsis started? | | DD/MM/YYYY HH:MM |
| | b. Were antibiotics started within 1 hour of arrival in hospital? | | Y/N |
| | c. Was the empirical choice of antibiotic in line with the recommendations? | | Y/N |
| | d. Was the definitive choice of antibiotic in line with the recommendations? | | Y/N |

| | | |
|---|---|---|
| | e. Was the antibiotic duration in line with the recommendations? | Y/N |

# APPENDIX 2
## STUDY PROFOMA

| **Variable** | **Median/Mode** |
|---|---|
| Age | |
| Gender | |
| Date of presentation | |
| Admission GCS<br>>13<br>12-8<br>7 and below | |
| Documented Temperature | |
| Documented Neck rigidity | |
| Documented HIV status | |
| Documented Headache | |

## APPENDIX 3: CONSENT FORM (STATEMENT OF CONSENT)

**Participant's statement**

I have read this consent form or had the information read to me. I have had my questions answered in a language that I understand. The risks and benefits have been explained to me. I understand that my participation in this study is voluntary and that I may choose to withdraw any time. I freely agree to participate in this research study.

I understand that all efforts will be made to keep information regarding my personal identity confidential.

By signing this consent form, I have not given up any of the legal rights that I have as a participant in a research study.

| **I agree to participate in this research study:** | **Yes** | **No** |
|---|---|---|
| | | |

**Participant signature / Thumb stamp**

**Date__**

**Researcher's statement**

I, the undersigned, have fully explained the relevant details of this research study to the participant named above and believe that the participant has understood and has willingly and freely given his/her consent.

**Researcher's Name** **Date**

**Signature:**

**Role in the study**

Contact information

**Dr. Githua Geoffrey** Telephone number: 0724093093

**FOMU YA IDHINI**

Nimesoma fomu hii. Nimepata fursa ya kujadili utafitii huu. Maswali yangu yamejibiwa kwa lugha ninayoielewa. Nimeelewa faida na hatari zinazotokana na utafiti huu. Nimeelewa kuwa kushiriki kwangu sio kwa lazima na ninaweza kujitoa wakati wowote ule.

Nakubali kushiriki kwenye utafiti huu. Naelewa kua juhudi zimewekwa kuhakikishwa habari nitakazozitoa zitakua ni siri.

Kwa kutia sahihi sijapoteza haki zangu kama muhusika.

Nakubali kushiriki katika utafiti huu **Ndio** **La**

Sahihi ya mshirika /alama ya kidole_____

tarehe

**Kauli ya utafiti**

Mimi niliyetia sahihi kwenye karatasi hii nimeeleza kwa kina mambo yote ambayo mshiriki aliyetajwa hapo juu anapaswa kuelewa na amekubali kushiriki katika utafiti huu bila kulazimishwa.

Jina la mtafiti_____ tarehe_____

Sahihi

Jukumu kwenye utafiti_____

Kwa maelezo zaidi wasiliana na

**Dr. Githua Geoffrey** Nambari ya simu:0724093093