Malaria Laboratory Diagnostic Capacity in Kisii County Level 5 Hospital, Kenya

Nyamongo Onkoba1,2, Valeria Bosire1 and Victor Mwangi1

1Tropical and Infectious Diseases, Institute of Primate Research, Kenya
2Department of Biomedical Sciences and Technology, the Technical University of Kenya, Nairobi, Kenya

*Corresponding Author:
Nyamongo Onkoba
Tropical and Infectious Diseases, Institute of Primate Research, Kenya
Fax: +254 020 882546.
Email: bwonkoba@primateresearch.org

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Abstract

In developing countries, malaria remains a major global public health concern whose laboratory diagnosis is paramount in its control. The present study sought to determine malaria laboratory diagnostic capacity in the Kisii Level 5 Hospital, Kenya by assessing staff capacity and competency. This was a cross-sectional, descriptive study conducted by administration of structured questionnaires to doctors, clinical officers, nurses and laboratory staff. Thematic content analyses were performed on qualitative data based on the framework and descriptive statistical analyses of quantitative data were conducted using Microsoft Excel and SPSS. Two thirds of the respondents (67%) affirmed the laboratory participated in malaria control programs within the area. The 8 hour shift scored 82% as the routine laboratory hours whereas laboratory accessibility was mostly between 3 to 5 days a week (64%). Laboratory diagnosis results were recorded in laboratory registers (56%) while others in log books and slide archives (both 22%). Poor slide preparation during diagnosis was observed. Fever, vomiting, headache and joint pain (90%, 72%, 62% and 56% respectively) were predominant used as symptoms for malaria by clinicians. The laboratory staff had basic level of education with certificate training in medical laboratory sciences. Malaria diagnosis was based on poorly prepared thin blood smears.

Introduction

It is estimated that over 500 million people suffer from malaria infections annually resulting in about 1-2 million deaths, of whom 90% are children in sub-Saharan Africa [1]. The number of malaria cases worldwide seems to be increasing due to increasing transmission risks in areas where malaria control has declined, the increasing prevalence of drug resistant strains of parasites and massive increase in international travel and migration [2]. The need for effective and practical diagnosis is essential for global malaria control [3] since effective diagnosis reduces morbidity and mortality from malaria. Differentiation of malaria from other protozoal infections based on patient’s signs and symptoms or physician’s findings may be difficult. Therefore, a confirmatory diagnosis performed in the laboratory is paramount in malaria management. Due to several campaigns and public awareness programmes geared towards controlling malaria have spurred interest in development of effective diagnostic strategies for resource-limited areas [4, 5].

However, in most malaria endemic areas expertise and training in malaria diagnosis is wanting. Identification of malaria parasites developmental stage in blood by microscopy is the gold standard of malaria diagnosis. Although this may seem simple, the diagnostic efficacy is subject to many factors like species of malaria parasites; the different stages of erythrocytic schizogony, the endemicity of different species, the interrelation between levels of transmission, population movement, parasitaemia, immunity, and signs and symptoms; drug resistance, the problems of recurrent malaria, persisting viable or non-viable parasitaemia, and sequestration of the parasites in the deeper tissues, and the use of chemoprophylaxis or even presumptive treatment on the basis of clinical diagnosis, can all influence the identification and interpretation of malaria parasitaemia in a diagnostic test.
In endemic areas, malaria should be treated as a major medical emergency and there should be no delays in diagnosis and treatment [6]. In areas where malaria cases have declined, diagnosis can be difficult because healthcare providers are unfamiliar with the diseases signs and symptoms. In some areas, clinicians mainly depend on symptoms like fever, headache, weakness, myalgia, chills, dizziness, abdominal pain, diarrhoea, nausea, vomiting, anorexia, and pruritus [7] as pathognomic signs of malaria. This is fatal because other infections caused by tissue-dwelling parasites like *babesia* sp., *trypanosomoses, leishmania* sp. have similar symptoms [8-10]. In addition, laboratory technicians may be unfamiliar with, or lack experience with, malaria, and fail to detect parasites when examining blood smears under a microscope [11].

In the 21st century, there is emergence of rapid and effective malaria diagnosis kits [12, 13] such as OptiMAL, immunochromatographic test, Para-HIT-f, ParaScreen, SD Bioline, Paracheck, [10, 14-19] and molecular diagnostic methods, such as Polymerase Chain Reaction (PCR) [20, 21] This test methods are quick, sensitive, precise but they are plagued with shortcoming like non-malarial parasite strain sensitivity, lack quantitative ability and above all the laboratory technicians are not well trained for effective diagnosis. Thus, the present study was designed to determine the malaria diagnostic capacity in the Kisii Level 5 Hospital by assessing training and competence of doctors, clinical officers, nurses and laboratory technician who are involved in malaria management.

### Materials and Methods

**Study site:** The study was carried out at Kisii Level 5 Hospital in Kisii County, Kenya. The hospital serves approximately 243,098 people from a population of 516,472 with an annual growth rate of 2.7%. Population density is estimated to be 766 per km² compared to the average growth rate in Kenya of 37 people per km². This overcrowding provides an ideal environment for rapid transmission of malaria to epidemic proportions. In addition, this is the only referral hospital in the lower Western part of Kenya hence it serves persons from Bomet, Nyamira, Homa bay and Migori counties.

**Study Design:** This was a cross-sectional, descriptive study that targeted the main health providers in the hospital who served in the diagnostic laboratory services as well as those who benefitted from the services offered in the laboratory facility. These i the doctors, clinical officers, nurses and laboratory staff.

**Sample size determination:** The sample size of the target population was determined according to *Fischer et al., (1998)*

As follows:

\[ n = \frac{z^2pq}{d^2} \]

Where:

- \( n \) = sample size
- \( z \) = standard normal deviation (1.96) which corresponds to 95% confidence limits.
- \( p \) = proportions of the target population estimated that will correspond to the questionnaires

Use \( p = 0.5 \) if \( p \) is not known

\[ Q = 1 - p \]

\[ D = \text{degree of accuracy usually 0.0 here } p = 0.5 \text{ assume } d = 0.13 \]

Thus, 50 clinical officers and doctors were taken as the sample size due to the population of the health delivery staff in the hospital.

**Sampling Procedure:** Structured questionnaires were developed and used to collect information for the study. Three sets of questionnaires were administered to first the laboratories in charge who were the section heads of microbiology laboratory, central laboratory and parasitology laboratories. The second questionnaire was administered to the medical laboratory staff in each section and lastly a focus interview was done to clinical officers and doctors. As well laboratory thin and thick blood smear observations were done to ascertain whether standard operating procedures were being followed by medical laboratory staff and comments were made.

The questionnaires administered to the heads of each laboratory unit focused on external affiliation of the laboratories, quality assurance and control, workload, laboratory facilities, equipment and expertise. The questionnaire administered to laboratory staff focused on techniques used in staining and examination of malaria parasites, methods used in estimating parasitaemia and laboratory records kept.

Interview with doctors and clinical officers focused on clinical signs and symptoms of malaria patients, diagnosis of malaria and prescriptions done. Those done with laboratory technologists gave information on how blood smears were prepared and examined.

Questionnaires to medical or laboratory staff were administered randomly to the personnel on duty once a month for three months and collected after one week. Interviews with clinical officers and doctors were administered once a month. Laboratory slide observations were done in all laboratories once. Interviews and questionnaires were administered to willing staff and the unwilling participants were excluded from the study.

**Data Analysis:** Raw data from the filled questionnaires were extracted manually and entered into a Microsoft Excel file then collated, cleaned and reviewed before analysis using the Statistical Package for Social Scientists (SPSS; version 21/2012; IBM, Armonk, New York, United States).

Bar charts were created to summarize the data collected. Data were analyzed and categorized into knowledge of the laboratory’s participation in malaria control programs, laboratory working hours, laboratory accessibility, results documentation and patient symptoms.

**Ethical Considerations:** The work was done within the framework of Ministry of Health and letters of authority were obtained from relevant county office. Privacy of the respondents was protected by keeping the information confidential and a written consent by the respondents sought before any information was revealed to avoid any physical or psychological harm. The respondents were informed of the purpose of the study prior to getting their consent, their identity was kept anonymous.
Results and Discussion

It was shown from the study that the respondents recognized the hospital as a level 5 hospital sponsored by the Government of Kenya. The hospital laboratories were adequately affiliated to several research institutions and were also a teaching and referral hospital for it has a medical training college that uses its laboratory facilities.

The essential health delivery personnel utilizing the laboratories were as per the presentation below. The study identified that general practitioners, clinical officers, nurses and medical consultants used the laboratory services well for diagnosis and health delivery.

It was found out that majority of the laboratory staff had diploma level training while those with certificate training with an average of five years working experience formed the other bulk of staff. However, there were no degree, masters or PhD qualified staff engaged in the laboratory services team. Other than these, there was also support staffs whose work was cleaning of apparatus.

Results indicate that the hospital's laboratory was involved in malaria diagnosis and control in the region (Figure 1). Malaria control strategies were developed by affiliate institutions. These affiliate institutions were also noted have provided the equipment used for the diagnosis of malaria. Laboratory staff not only worked within the hospital premises but also got involved in community mosquito collections that were used by researchers in development of adequate control methods used in the region during peak and off-peak sessions. From the study, it was indicated by 67% of the respondents that the laboratory was mainly involved in malaria control.

The laboratories worked for 8 hours for 5 days in the diagnosis of specialized tests as per 82% of the respondents. The diagnosis of malaria was done 24 hours all year round and it included routine tests like haemoglobin estimation, a sub branch of malaria diagnosis (Figure 2).

The laboratories were accessible freely in a span of more than three days (Figure 3). Services can thus be determined to be adequately delivered for most times in the week. Of interest was that the workload was observed to be high during the peak months of transmission of malaria that is April, June and July. The ratio of staff to the number of patients per hour during peak period was estimated at 1:23 (data not shown).

According to the questionnaires obtained from the laboratory staff, most of the malaria diagnosis results were kept in laboratory register. Positive slides were kept in slide archives for teaching attaché students. Logbooks and notebooks were available and were used for record maintenance (Figure 4).

From the clinicians’ perspective, several symptoms were used as indicators for malaria in patients. These included: fever, abdominal pains, headache, jaundice in children, joint pains, rigors and chills, vomiting and diarrhoea. Fever, vomiting, headache and joint pain (90%, 72%, 62% and 56% respectively) were the most observed symptoms by the clinicians while rigour and jaundice (6% and 4% respectively) were the least observed in patients suspected to have malaria (Figure 5).
From the general responses, blood slide preparation process and observation, it was clear that the laboratory malaria diagnosis was incompetent. The laboratory had a lot of irregularities committed that were not noted.

The study indicated that the equipment used for malaria diagnosis were insufficient because the colorimeter used for haemoglobin estimation gave non reproducible results to patients. The exact malarial condition was not shown because patients only received a single blood slide result that was poorly stained and examined. The laboratory staff was not well trained hence its efficiency and diagnostic capacity for malaria was questionable. After prophylactic treatment the patients were never sent to the laboratory for review. The microscopic examination technique used did not show the parasitaemia density for the slides were poorly prepared, only probable estimation was done. The field stains prepared were not quality controlled. There was cross-contamination of slides for they were not properly fixed. There are several pathophysiological symptoms of malaria hence clinicians need to include symptoms like respiratory distress, unconsciousness and coma because not all fevers and headaches should be broadly as indicative signs of malaria. Standard operating procedures were never available.

References