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The influence of training outcome and competency on effective utilization of malaria microscopy result amongst health professionals in South Eastern Nigeria

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Malaria diagnosis in Nigeria mostly relied on clinical manifestations until 2011, when the government issued a policy requiring parasitological confirmation of all suspected malaria cases prior to treatment. Poor usage of malaria test results in health care delivery is one of the possible causes of over-diagnosis and over-treatment of malaria in Nigeria. This study demonstrated the influence of in-service training on malaria microscopy amongst medical laboratory scientists on the utilization of malaria microscopy results in a selected Government Health Facility in Nigeria. A paired t-test was conducted to determine statistically significant differences between pre-test and post-test results at 0.05 significance level and ANOVA to determine if there were differences in knowledge level before and after the training and between the basic and refresher training. The study demonstrates a significant improvement in both the basic and refresher training mean parasite detection pre-and post-tests scores from 56.3% (95% CI 53.6-58.8%) to 77.7% (95% CI 74.4-80.2%) and 76.7 (95% CI 74.2-79.2%) to 91.2% (95% CI 88.3-94.1%) (*P*<0.001). When comparing the rate of utilization of malaria results from trained medical laboratory scientists to the baseline and follow-up studies, as well as the assessment of facilities' malaria test requests and utilization pattern during the study period, there was a substantial difference (*p*<0.001). The increase in utilization of malaria microscopy result for effective case management of malaria in the study area was influenced by training outcome and competency of medical laboratory scientists.

Key words: Malaria results, microscopy training, medical laboratory scientists, health care providers.

INTRODUCTION

Parasitological confirmation of suspected malaria cases is an important part of effective malaria case management because it reduces morbidity and mortality thereby, preventing chronic infection that results in malaria-related anemia, as well as the formation and spread of antimalarial drug resistance. Training is becoming increasingly complex, and tools to determine the proficiency of training programs and trainees are needed as there are gaps in adequate utilization of malaria microscopy results by health care workers which have resulted in treatment of all suspected fever cases for malaria irrespective of the parasitologically confirmed malaria status. The changing trend of disease transmission of jungle fever in Nigeria from high endemicity to hypoendemicity suggests that far reaching hypothetical treatment may prompt over-utilization of antimalarial meds given decreased intestinal sickness rates (Nwokolo et al., 2018). Some of the major drawbacks on utilization of malaria results are linked to the practice of treatment based on clinical diagnosis alone (Oladosu et al., 2013). The National Guideline for Diagnosis and Treatment of Malaria in Nigeria (2015) suggests the utilization of microscopy just in tertiary and research facility administrations with qualified lab scientists. Malaria rapid diagnostic tests (mRDTs) are suggested for use in PHC settings where there are no certified lab scientists. In most Sub Saharan African countries, both tests are needed, as RDTs and microscopy often play different roles according to the clinical situations or setting.

Microscopy-based diagnosis of malaria still remains the gold standard for species identification, parasite quantification and assessing therapeutic efficacy of anti-malaria drugs (WHO, 2009; Hanscheid 1999; Ashraf et al., 2012). However, the quality of microscopy is frequently inadequate to enhance prompt and effective case management and optimal use of scarce health resources and this is still a concern. Laboratory results varies considerably mainly as a result of varying competencies of the microscopists, quality of reagents and equipment used, and lack of efficient quality control procedures; this has placed some level of concern on the quality of malaria microscopy results despite its gold standard status.

Studies have demonstrated an improvement in performance and competency of microscopists in diagnosis of malaria as a result of effective training; while others have also demonstrated the effectiveness of in-service training on malaria microscopy diagnosis, which has been reported to improve the performance of medical laboratory scientists or microscopists (Nateghpour et al., 2012; Moura et al., 2014; Olukosi et al., 2015). Nigeria through the support of various donor agencies and implementing partners have strengthened malaria diagnosis by provision of Basic Malaria microscopy courses to Medical Laboratory Scientists working in various Government Health institutions; however, available documented information in Nigeria on the utilization of malaria results generated by Medical Laboratory scientists in management and treatment of malaria in government health institutions is scanty as there is growing evidence of over diagnosis and over treatment of malaria in Nigeria (Hanscheid 1999; Okoro et al., 2015; Aiyenigba et al., 2017; Kiggundu et al., 2011). Data on the impact of competency and training of Medical Laboratory Scientists on utilization of malaria results is needed to provide evidence on the need for a sustainable Malaria Quality assurance program in all government health facilities.

METHODS

In 2014, a baseline study was conducted, and a follow-up study was conducted in which end users of laboratory results in selected secondary health facilities were given a pre-tested questionnaire on perception and utilization of malaria microscopy results by health care providers in malaria case management and Basic malaria microscopy training conducted for medical laboratory scientists working in these selected facilities in accordance with the World Health Organization (WHO) basic microscopy training manual. Level of improvement and confidence in malaria result utilization by health workers was assessed. Test scores and participants' registration, health care provider's data were extracted using Microsoft Office Excel® 2010 template; data was cleaned and exported to Stata 11, Stata Corp. 2009. *Stata Statistical Software: Release 11*. College Station, TX: Stata Corp LP for data analysis. To assess the performance after the training intervention, paired-test was used to determine if there was any significant difference between the performance scores before and after the training, between the basic and refresher training and between pre and post training malaria result utilization.

Study sites

This study sites were two Government health facilities with laboratory scientists, 2 (two) Stand-aloneprivate Medical Laboratories and 2 Private hospital Laboratories that renders services to clinicians and/or health care providers. The base line and follow up studies were conducted in 2014 and 2017 respectively. The populations studied were health care providers who utilize malaria result from the selected Laboratories and also Medical Laboratory scientists (MLS) from the selected Laboratories who consented to the study. The training site was Federal Medical Center Owerri, one of the selected government health facility withininfrastructure and facilities for conducting malaria microscopy in Imo State, Nigeria.

Training materials

Training materials included a CX 21 Olympus binocular microscopes,

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pH meter and malaria microscopy consumables. Participants were also given laminated bench aids and a CD-ROM of *Plasmodium* parasites identification slides and slide preparation templates. These learning materials were designed to aid participants at work after the training.

Study design

About 25 Health care providers cutting across various professions and 10 Medical Laboratory scientists were enrolled for the study after obtaining Informed consent from them.

During the 2014 base line study, key data on malaria treatment policy and guideline, malaria diagnostic test results, utilization of malaria test result, resistant malaria among others were collated from the consenting health care providers using a pre tested questionnaire and also focused group interviews. Basic malaria microscopy training was conducted for selected medical laboratory in accordance with the World Health Organization (WHO) basic microscopy training manual. The goal of the training was to provide required knowledge and skills to improve participants' competency and proficiency in identifying malaria plasmodium species for making accurate malaria diagnosis using microscopy. The training also provided adequate support to the participants on quality malaria slide preparation which is the foundation of good microscopy. The Trainers were qualified medical Laboratory scientists who were certified by WHO as expert microscopists. The training was followed up by a supportive supervision visit to the Medical Laboratories where other factors that can adversely affect microscopy results such as the necessary equipment and reagents for staining and visualization, good working conditions were addressed and put in place by the participating health facilities. A follow up refresher training of the MLS on malaria microscopy was conducted in 2017 to further provide assistance in the gaps observed especially as regards specie identification and parasite quantification (Density count)

Training process

The training was an intensive 6 days malaria course based on WHO basic microscopy learners guide while the refresher training was for 5 days. The training approach consisted of a series of didactic lectures, group presentations; problem based learning, Giemsa stain preparation, power point presentations on implementation issues related to malaria blood film preparation, staining of blood films with Giemsa stain, and examination of high quality teaching stained slides for the major *Plasmodium* species. Also, lectures on slide reading and counting basics were repeated each morning between the 3rd and 10th day of the training to ensure participants understood the fundamentals of Plasmodium species detection, staging and speciation (WHO).There was daily continuous assessment which was aimed at identifying and resolving knowledge gaps. Training outcome was measured by the administration of pre and posttest knowledge assessment written and computer-based picture tests, pre and post slide reading which involved parasite count (density count), Parasite detection and Specie identification. Participant's pre and post training sensitivity and specificity were also assessed.

Sensitization and assessment of health care providers/health care facilities

The clinicians and other health care providers who were enrolled in the study were sensitized on the level of competency of the Laboratory scientists who were given Basic Malaria Microscopy training and the need to accept their malaria results. The sensitization meeting was followed up by yearly assessment of the two private/mission hospitals' malaria test request and treatment pattern between 2015 -2017; While another set questionnaire was used to get data from the Health care providers on, Quality of malaria diagnostic test results, Utilization of malaria test result, adherence to malaria treatment policy and guideline and Resistant malaria among others .Overall level of improvement and confidence in malaria result utilization by health workers within the study period was analyzed.

Inclusion criteria for participant's selection

1. Only the health care providers identified by the selected laboratories as their clients who consented to the study and were willing to provide information were enrolled**.**
2. Selected facilities nominated Medical laboratory scientists involved in routine malaria diagnosis in his/her facility who were willing and available to participate fully in all training sessions.

Statistical analysis

Test scores of the basic and refresher training were extracted using Microsoft Office Excel® 2010 template; data was cleaned and exported to Stata 11, Stata Corp. 2009. *Stata Statistical Software: Release 11*. College Station, TX: Stata Corp LP for data analysis. To assess the performance after the training intervention, paired-test was used to determine if there was any significant difference between the performance scores before and after the training and between the basic and refresher training. Statistical significance level was set at 0.05 and a two-tailed paired t-test was conducted to compare pre-and post-test mean scores.

RESULTS

Results from the general characteristics of medical laboratory scientist trained on malaria microscopy and general characteristics of Health Care providers interviewed on malaria Microscopy results are shown in Tables 1 and 2. Analysis shows that the sex (male/female), type of health facility and type of health professional did not significantly (P=0.0523, P=0.134, P=0.346, P=0.3445) affect the participants' knowledge and comprehension during the refreshed training.

Comparing the pre-post training data of the basic malaria microscopy training, there was significant improvement on all the parameters of assessment (Table 3).

Data from Basic-and Refresher post malaria microscopy training assessments on slide reading showed significant improvement on all parameters used (Table 4 and Figure 1).

Table 5 shows the statistical significant difference in both pre-and post-tests scores for basic training detection tests when compared with refresher training slide reading detection tests ($P < 0.05$).

DISCUSSION

This study has demonstrated the effectiveness of malaria

Table 1. Distribution of general characteristics of medical laboratory scientist trained on malaria microscopy.

Characteristics		Frequency *n* = 12 (%)
Sex	Male	7 (70.4)
	Female	5 (29.6)
x^2		4.22
p value		0.0523
Type of health facility	Secondary	3 (25)
	Tertiary	3 (25)
	Standalone Lab	4 (33.3)
	Private/Mission Hospital	2 (16.7)
x^2		7.3422
p value		0.134

Table 2. Distribution of general characteristics of health care providers interviewed on malaria microscopy results.

Characteristics		Frequency *n* = 25 (%)
Sex	Male	12 (48)
	Female	13 (52)
x^2		9.674
p value		0.346
Type of health professional	Clinicians	12 (48)
	Nurses	7(28)
	Pharmacists	3(12)
	Community health workers	3(12)
x^2		12.45
p value		0.3445

Table 3. Results of basic training test of significance of mean pre-and post-test scores using paired sample t-test.

Category of test	Pre-test		Post-test		*P*-value
	Mean (%)	95% CI	Mean	(95% CI)	
Slide reading tests					
Detection	56.3	53.6-58.8	77.7	74.4-80.2	<0.001
Speciation	21.2	18.3-24.1	40.4	36.6-44.2	<0.001
Specificity test	38.9	34.1-43.7	70.4	65.6-75.2	<0.001
Sensitivity test	67.4	63.2-71.6	88.3	85.3-91.3	<0.001
Counting test	8.3	6.7-9.9	24.3	21.7-26.9	<0.001
Computer-based tests					
Picture detection	75.9	72.8-79.0	92.3	90.4-94.2	<0.001
Picture speciation	40.5	37.1-43.9	58.3	55.3-61.3	<0.001
Picture staging	36.9	33.1-40.7	72.8	70.3-75.3	<0.001
Written test					
Writing test	41.2	39.5-44.6	64.3	62.0-66.6	<0.001

Table 4. Results of refresher training test of significance of mean pre-and post-test scores using paired sample t-test.

Category of test	Pre-test		Post-test		*P*-value
	Mean (%)	95% CI	Mean	(95% CI)	
Slide reading tests					
Detection	76.7	74.2-79.2	91.2	88.3-94.1	<0.001
Speciation	67.1	64.2-70.0	69.6	65.8-73.4	<0.001
Specificity test	69.5	64.7-74.3	87.8	83.0-92.6	<0.001
Sensitivity test	79.0	74.8-83.2	94.3	91.3-97.3	<0.001
Counting test	26.6	25.0-28.2	40.7	38.1-43.3	<0.001

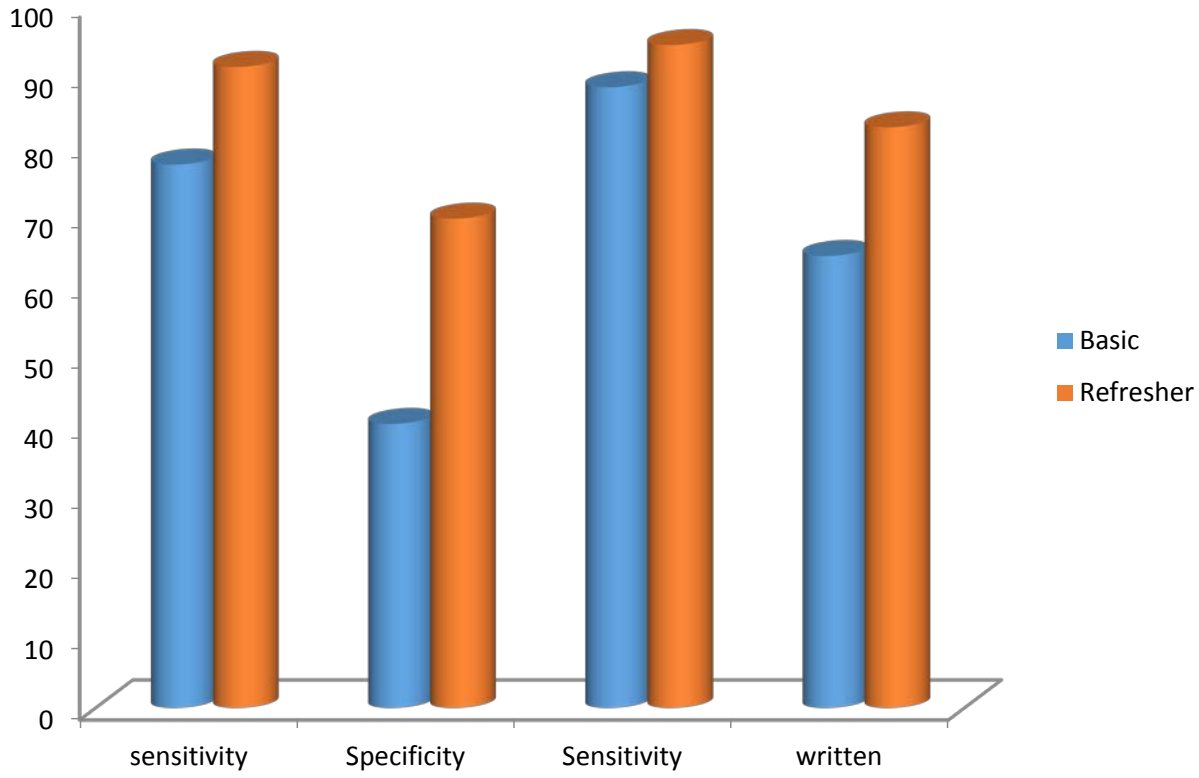

Figure 1. Basic-and refresher training post malaria slide reading assessments

microscopy training as a tool to optimize malaria microscopy result acceptance and utilization for treatment by health care providers. The health care workers' perception and utilization rate were assessed using a well-structured questionnaire while the medical Laboratory scientists' performances and basic competency levels were assessed using written, slide reading and computer based picture tests. Overall, the training impacted positively the post -test performance of participants' malaria diagnostic knowledge and ability to interpret real malaria stained slides which is consistent with results from other studies (Kiggundu et al., 2011; Bal et al., 2019; Aiyenigba et al., 2017). This study reports the increase in utilization of malaria microscopy result by health care providers in malaria case management as a result of an in- service training outcome and competency (Table 6).

Our results show improved adherence to malaria microscopy result during treatment of patients. Refresher training on malaria case management for clinicians and them being aware that the hospital laboratory or standalone laboratories being patronized by them have competent malaria microscopists who receive various forms of refresher trainings including on the job training by experts had positive influence on the adherence and utilization of malaria microscopy results and make them confident to search for other etiologies of fever.

Table 5. Results of test of significance using paired t-test to compare parasite detection tests of Refresher training when compared with basic microscopy training pre-and post-tests.

Category of test	Mean test score (95% CI)	*P*-value
Basic training slide reading detection pre-test	56.3 (53.7-58.7%)	<0.001
Refresher training slide reading detection pre-test	76.7 (74.2-79.2%)	
Basic training slide reading detection post-test	77.3 (74.4-80.2%)	<0.001
Refresher training slide reading detection post-test	91.2 (88.3-94.1%)	

Table 6. Distribution of factors that influence the utilization of malaria microscopy results in case management.

Variable	Frequency (%)
Microscopy results most times in conflict with clinical signs suggestive of malaria	100
High level of Negative malaria result	88
Confidence in malaria microscopy test results	84
Microscopy results not readily available to make decision when RDT is negative	82
Not aware of malaria microscopy course designed to enhance the competency of the Medical Lab. Scientists on bench	72
Presumptive presence of resistant malaria in persistent fever cases	58

The very low mean pre-test scores on counting and specie identification (speciation) as shown in Table 3 are consistent with the report of (Olukosi et al., 2015; Aiyenigba et al., 2017) whose studies took place in Nigeria. In this study counting test scores increased from 8.3 to 21.7%. The pretest counting score of 8.3% as compared with 0 and 4.2% reported in previous studies (Olukosi et al., 2015; Aiyenigba et al., 2017) can be attributed to the previous malaria microscopy training received by three (3) of the Medical Laboratory Scientists through the support of Society for family Health (SHF); similarly, the margin of increase of the slide reading speciation test scores in all this study (19.2%) was similar to the study by Aiyenigba et al. (2017) (19.4%) as compared to olukosi et al. (2015) who reported 11.3% in their study.

Furthermore, the significance difference in the mean test scores of trainees' sensitivity and specificity (Table 4) showed that the training had positive impact and the Medical Laboratory scientists are closer to becoming experts in declaring a slide negative or positive and their results could be relied on during treatment.

The overall poor performance of the participants in identification of parasite species and quantification during the pre-tests microscopy training when compared with the post test scores agrees with this study (Aiyenigba et al., 2017) and further corroborates their representation that the level of Malaria microscopy competency by medical Laboratory in the country is inadequate for a nation with a high malaria burden that has progressed into malaria elimination phase. Detection and quantification of malaria parasites are important skills in monitoring disease severity and drug efficacy and will provide great guidance to end users of malaria results; hence the competency of Malaria microscopist cannot be compromised.

This study agrees with previous studies (Edson et al., 2010; Barber et al., 2013; Aiyenigba et al., 2017) that demonstrated difficulties and/or challenges in parasite speciation and quantification by trainees. It was recommended that a periodic in-service malaria microscopy training, review of malaria diagnosis content and formal training curriculum for medical laboratory scientists to deliver sufficient quantities of lab researchers can bolster Nigeria's journey to eliminate intestinal sickness as the nation joins the league of nations on the road to malaria elimination (Aiyenigba et al., 2017).

Where sustainable Malaria EQA program is not established as in Imo state, south eastern Nigeria, malaria microscopy result may not be guaranteed as health care providers consuming those results may not be aware of the competency and quality of malaria results. A study in Kenya corroborated this fact that positive influence on adherence to malaria microscopy during treatment of out-patients in a County Referral Hospital was as a result of provision of refresher training on malaria case management for clinicians and awareness by clinicians that the hospital laboratory participates in national QA scheme (Odhiambo et al., 2017).The importance of highquality microscopy as it is used to confirm mRDT diagnosis, perform Plasmodium speciation, quantify parasitaemia and as well monitor treatment outcome had already been established (WHO, 2010; WHO, 2015).

The baseline study elicited the possible factors that will influence the utilization of Malaria test results (Table 6) by health care providers and their response are

enumerated in the descending order of frequency: Microscopy results most times in conflict with clinical signs suggestive of malaria (100%), High level of Negative malaria results (88%), Confidence in malaria microscopy test results (84%), Microscopy results not readily available to make decision when RDT is negative (82%) while 72% indicated not being aware of malaria microscopy course designed to enhance the competency of the Medical Lab. Scientists. 48% responded that they were likely to always treat without confirmation while 48% responded that they sometimes treat patients with antimalarials for fever without carrying out diagnostic tests. Only 4% admitted that they strictly adhere to parasite confirmation before treatment.

The follow up assessment on health workers utilization of the microscopy results generated from the trained Medical Laboratory scientists showed an improvement, 74% indicated high confidence in Malaria result and also appreciated the additional information of parasite density provided. The competency of microscopist determines to a large extent the accuracy and utilization of test results as detection and identification of parasites is of high sensitivity. Qualities of malaria blood films, staining and microscopes also play important roles in test accuracy (Ashraf et al., 2012). Further heath care workers may be trained with foldscope as diagnostic tool for identification of parasites (Bal et al., 2019).

Our results show commendable adherence and a positive paradigm shift towards the acceptance of malaria microscopy test results by some of the health care providers. We recommend refresher training and sensitization of clinicians and health care providers on malaria case management policies and the need to utilize results produced by competent/well trained malaria microscopists. To improve the overall effectiveness of malaria prevention and elimination efforts in Nigeria, public and private medical Laboratories/Medical Laboratory scientists within the state should be encouraged to participate in the state's malaria EQA program. This study is therefore advocating for a sustainable EQA scheme in all public and private health facilities in Imo State, Nigeria.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

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