SCHOOL OF PUBLIC HEALTH

COLLEGE OF HEALTH SCIENCES

UNIVERSITY OF GHANA

ASSESSMENT OF FACTORS INFLUENCING THE USE OF MALARIA RAPID DIAGNOSTIC TEST IN HEALTH FACILITIES IN OBUASI, GHANA

BY

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A THESIS SUBMITTED TO THE SCHOOL OF PUBLIC HEALTH, UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PUBLIC HEALTH (MPH) DEGREE

DECEMBER, 2018

DECLARATION

I, Richard Opoku, declare, that except for other people's investigations which have been duly acknowledged, this work is the result of my own original research and that this dissertation, either in whole or part has not been presented elsewhere for another degree.

Richard Opoku (STUDENT)

Signature.....

Date. 11.12.18

Supervisor's Name: Dr. Reuben K. Esena (ACADEMIC SUPERVISOR)

Signature: .....

Date: 11-12-18

DEDICATION

To my supportive wife, Abigail and two lovely daughters, Demra and Foforo

ACKNOWLEDGEMENT

My utmost gratitude goes to God Almighty, Creator of the universe and the giver of life who has brought me this far. Some individuals allowed themselves to be used by God to bring this project to fruition.

Key among those who directed affairs of the study are the following staff of the Department of Health Policy, Planning and Management and other lecturers in the School of Public Health University of Ghana: Dr. Reuben K. Esena (Project Supervisor); Dr. Augustine Adomah-Afari (mentor); Dr. Patricia Akweongo (mentor); and all the lecturers of the University of Ghana's maiden Sandwich Master of Public Health class

I am also grateful to the Director of Obuasi Municipal Health Directorate, Dr. David Kwasi Amankwa, and all the health facilities involved in the study (Obuasi Government Hospital, AngloGold Ashanti Health Foundation, Todah Hospital, Bryant Mission Hospital, and Saint Jude Hospital) and the AngloGold Ashanti Malaria Control Programme for allowing this study in their outfit.

To all the research assistants who aided me in the collection of data for this study, especially, Emmanuel Akoto, a graduate of University of Cape Coast and former national service personnel attached to the Laboratory Department of the Seventh-day Adventist Hospital, Obuasi, I am so thankful for your support.

ABSTRACT

Background: The use of malaria rapid diagnostic test (RDT) kits is recommended in health facilities where there is so much pressure on microscopy to avoid delay of patients. However, the initiative has been bedevilled by many challenges. Not every suspected malaria case is pathologically confirmed and even among those tested, adherence to test result is often poor.

Objective: The main objective of the study was to determine factors influencing the use of RDT in malaria diagnosis in the Obuasi Municipality. Specific objectives were to examine the proportion of patients tested for malaria with the use of RDT kits at the health facilities in the Obuasi Municipality; determine patient factors associated with the use of RDT kits for testing malaria at the health facilities; and to explore health system and organization factors influencing the use of RDT kits for testing malaria at the health facilities in the Obuasi Municipality.

Methods: The study applied a retrospective cross sectional design in the selection and use of patients' folders to establish the proportion of patients tested for malaria using RDT kits while semi-structured interviews were applied to collect data from the health providers on the health system and provider factors influencing the use of RDT kits for testing malaria at the health facilities. Thus, the study utilized both qualitative and quantitative methods. Prescribers and medical scientists from five purposively selected facilities of the five sub-municipalities of the Obuasi Municipality and public health officers from the Obuasi Municipal Health Directorate and the Anglo-Gold Ashanti Malaria Control Programme were recruited. Transcribed data from interviews were analysed thematically. Quantitative data was retrieved from patient folders sampled randomly based on laboratory registers' numbers of individuals tested for malaria within the month of June, 2017 in the selected health facilities. Quantitative data was analysed using Stata version 15.

Key findings: The proportion of patients tested for malaria with the use of RDT kits at the health facilities in the Obuasi Municipality in the selected health facilities was 43%. Overall, the perception of respondents of malaria rapid test kits was good. Stock out of the rapid diagnostic test kit and its limitation such as inability to detect all species of malaria were some of the reported challenges with the testing of all cases and adhering to test results.

Conclusions/Recommendation: Given the usefulness of rapid testing in health facilities to reduce patient turnaround time, kits used should be of the possible best quality. Local manufacturers should be encouraged to invest in malaria rapid test kits production.

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LIST OF ABBREVIATIONS

AGA	AngloGold Ashanti
ACT	Artemisinin-based Combination Therapy
CHPS	Community-based Health Planning and Services
DHIMS	District Health Information Management Systems
GHS	Ghana Health Service
IDI	In-depth interviews
***Pf*HRP2**	*Plasmodium falciparum H*istidine-Rich Protein2
***Pf*HRP3**	*Plasmodium falciparum H*histidine-Rich Protein3
RDT	Rapid Diagnostic Test
MLS	Medical Laboratory Scientist
MLT	Medical Laboratory Technician
MO	Medical Officer
MP	Malaria Parasites
OPD	Out Patient Department
OMHD	Obuasi Municipal Health Directorate
OTSS	On-Site Training and Supportive Supervision
PHO	Public Health Officer
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.0. Background to the study

Ghana enrolled in the World Health Organization's *Roll Back Malaria Initiative* in a global fight to bring down malaria burden to 75% by 2015 (GHS, 2017). An important component of this initiative was to promptly diagnose suspected malaria cases and treat effectively, using an appropriate means of diagnosis and antimalarial at all levels of healthcare, including the public and government sector institutions and the community (WHO, 2011a). However, in most malaria endemic regions, misdiagnosis commonly occurs due to limited reliable pathologic diagnosis leading to caregivers resorting to presumptive treatment (Ezeoke et al., 2012).

In settings where quality microscopy services are not available, rapid diagnostic test (RDT) is recommended (Visser et al., 2017). In the promotion of getting all suspected malaria cases tested, the Ghana Health Service recommends RDT use in facilities without laboratories or where the workload is such that turnaround time might be unbearable (GHS, 2015). Nonetheless, there are reported cases of treatment even when test results are negative (Boadu et al., 2016). However, it is recommended that every malaria treatment is confirmed to ensure that antimalarial drugs are not wasted and diseases other than malaria receive appropriate and timely treatment (Boadu et al., 2016).

According to the WHO Global Malaria Programme, engineering problems, parasite genetic characteristics, operator error, parasite load in patient's blood are some of the causes of unsatisfactory RDT test results (GMP, 2016). RDT usage has been seen to be hindered by healthcare delivery challenges (such as unsteady supply of malaria RDT, inadequate quality assurance and control and insufficient guideline emphasis on the kit), staffing problems, health worker perceptions, social changing aspects of health care delivery (anticipated norms of

provider-patient communication, test affordability) and limited involvement of frontline workers in policy processes leading to disjointed execution of health sector policies (Boadu et al., 2016).

Obuasi is a cosmopolitan municipality in the Ashanti Region of Ghana. Mining activity in the area makes Obuasi an important locality in terms of health research (Yeboa, 2008). In 2006, a malaria control programme was started by the Anglo Gold Ashanti in collaboration with Ghana Health Service to create awareness, control vector, engage in elimination of larvae of mosquitoes, indoor residual spraying and diagnose and promptly treat malaria. The programme has contributed massively to the fight against malaria (Aabeyir, 2010; Kharma, 2016). The National Malaria Control Programme (NMCP) with funding from Global Health has made available to the Ghana Health Service malaria RDTs which are supplied to health facilities in Ghana to test for all suspected malaria cases (GHS, 2015).

This study sought to assess the factors associated with the use of malaria rapid diagnostic test kits in health facilities in Obuasi: Health worker perceptions and perceived challenges with malaria RDT usage were explored; the proportion of RDT usage among clients tested for malaria and patient factors associated with prescriber's compliance to test results were examined. In the five selected health facilities, malaria rapid testing is usually done at the laboratory. Therefore, the health workers interviewed included medical laboratory scientists. Prescribers, municipal health directorate officers involved in malaria control and officers from the AngloGold Ashanti Malaria Control Programme were also interviewed. Prescribers include medical doctors, physician assistants and nursing officers who may prescribe medication to patients in the health facility.

1.1 Problem Statement

An estimated 438, 000 deaths out of 214 million cases of malaria in 2015 worldwide, were reported by the World Health Organisation (WHO, 2015b). About 395, 000 representing 90% of the estimated deaths occurred in Africa (WHO, 2015). In the Obuasi Municipality, malaria was the number one cause of visit to the hospital in 2016.

Globally, Cohen and colleagues (2012), estimated that the consumption of malaria drugs by people who are not suffering from the disease is "half global demand" (Visser et al., 2017). The WHO African Region recorded 87% of patients suspected of suffering malaria being tested in 2016 (WHO, 2018).The Ghana Health Service reported that the proportion of OPD cases suspected of having malaria in 2016 was about 39%. Of these, about 22.7% were not tested. Among those tested, only 43.4% was confirmed positive (GHS, 2016). Of the 55, 293 suspected cases of uncomplicated malaria in the Obuasi municipality in 2016, only 45.3% (25,072) was tested. About 30,000 representing 54.3% of the suspected cases were treated with antimalarial drug but not tested (OMHD, 2017).

Abuse of antimalarial drugs (which is a risk factor for antimalarial resistance), wastage of resources, and misdiagnosis of other diseases with similar signs and symptoms to malaria are as a result of presumptive diagnosis of malaria (Baiden et al., 2012). Clinical symptoms exhibited by uncomplicated malaria cases are inexplicit and similar to other diseases, thus, presumptive treatment lead to over diagnosis of malaria (Ansah, Epokor, Whitty, Yeung, & Hansen, 2013).

Elevated body temperature has often been used to presumptively diagnose malaria (Danquah et al., 2016). The abuse of antimalarial is worsened by the attitude of people in malaria endemic communities who purchase drugs in medicine outlets at the expense of seeking professional medical advice when a person feels feverish (Cohen *et al*, 2015). Long turnaround time, non-

availability of medical supplies and long distance proximity to health facilities have been cited to cause people's preference for these medicine outlets (Cohen et al., 2015).

There is a surge in global procurement of malaria RDT kits (Ansah-koi, 2016a). From 2010–2016, the quantity of RDT kits purchased globally from manufacturers eligible for Malaria RDT Product Testing Programme was 1.66 billion (WHO, 2018). Demand for RDTs increased from 240 million in 2015 to 269 million in 2016 in Africa (WHO, 2018).

Research has shown that the introduction of rapid testing in settings that rely on presumptive treatment of malaria has led to drastic reduction in artemisinin-based antimalarial overuse (Bastiaens, Bousema, & Leslie, 2014). In an ideal situation, the availability and use of reliable and easy to use test will lead to a change from presumptive diagnosing to testing before treatment of malaria (Bastiaens et al., 2014).

A full course of ACT is more expensive than RDT and so the use of RDT will improve both cost and management of malaria (Bisoffi, Gobbi, Angheben, & Ende, 2009). As many countries including Ghana and other developing countries rely on ACTs as first line of treatment of malaria, substantial overtreatment with ACT is of public health importance since it can lead to undesirable effects in the fight against the disease (Ansah et al., 2013).

The opinions of prescribers impact their prescribing practices(Mubi et al., 2013). Therefore, this study sought to assess factors influencing the use of malaria RDT in health facilities in the Obuasi Municipality in the Ashanti Region of Ghana.

1.2 Justification

Malaria continues to top the list of diseases accounting for patients visit to heath facilities in Obuasi (OMHMD, 2017). Although many health facilities in the Obuasi Municipality have access to microscopy, the use of rapid diagnostic testing for the detection of malaria is widespread in all health facilities. In Obuasi, over 54% of suspected malaria cases were not

tested prior to treatment for the year 2016 (OMHD, 2017).Consumption of artemisinin based combination therapy (ACT) by individuals who are actually not sick of malaria is a misuse of resources (Bisoffi et al., 2009). Abuse of ACT makes people susceptible to antimalarial resistance and increases burden to other diseases because their treatment is missed or delayed (Baiden et al., 2012).

Given the ease of test and timeliness of the test kit, increase in the use of RDT in malaria diagnosis can help bridge the gap between presumptive treatment and testing before treatment of malaria in Obuasi.

Ghana adopted the policy of testing before treatment and compliance to test results in the management of malaria. The introduction of the RDT was targeted at getting every suspected case at every level of healthcare tested before treatment (GHS, 2015). Although initially made for peripheral facilities without microscopy service, malaria RDT use has been advocated for by the Ghana Health Services in higher health facilities with microscopy where the laboratory has closed or when patient load is high and turnaround time is a problem (GHS, 2015). The aforementioned move was aimed at getting every suspected case tested.

This study is targeted at assessing the factors influencing RDT use in the diagnosis and treatment of malaria in facilities with microscopes in Obuasi. Research on the use of the RDT technology in health facilities with microscopy in Obuasi are lacking.

Reflexivity is helpful in developing rigour in ensuring trustworthiness of qualitative research results(Krefting, 2018). The researcher is a medical laboratory scientist who has worked in the health sector for a while. Therefore, the experiences gained would be brought to bear on the discussion relating to the topic and discipline. Policy makers can take clue from findings of the research to fortify control strategies required to improve on quality and quantity of malaria RDT

supplied and also improves compliance of prescribers with the test-based malaria policy towards the attainment of their goal. The study outcome can also help fill the gaps in literature.

1.4 Objective

1.4.1 General objective

The general objective of the study was to determine factors influencing the use of RDT in malaria diagnosis in the Obuasi Municipality.

1.4.2 Specific objectives are to:

The following specific objectives were addressed to achieve the general objectives:

1. To examine the proportion of patients tested for malaria with the use of RDT kits at the health facilities in the Obuasi Municipality.
2. To determine patient factors associated with the use of RDT kits for testing malaria at the health facilities in the Obuasi Municipality.
3. To explore health system and historical factors influencing the use of RDT kits for testing malaria at the health facilities in the Obuasi Municipality.

1.4.3 Research questions

The specific objectives were answered by asking the following questions:

1. What is the proportion of patients tested for malaria with the use of RDT kits at the health facilities in the Obuasi Municipality?
2. What patient factors are associated with the use of RDT kits for testing malaria at the health facilities in the Obuasi Municipality?

3. How do health system and historical factors influence the use of RDT kits for testing malaria at the health facilities in the Obuasi Municipality?

1.5 Outline of the study

Chapter one presents the introduction to the study. Chapter two seeks to review existing literature on the topic and present conceptual framework of the study. Chapter three explains the methods used in the study. Chapter four conveys results. Chapter five is about discussions based on the research findings of the study. Chapter six seeks to present conclusions and recommendations. The references section conveys the sources of scholarship used in the study. Appendices seek to present the various questionnaires, data extraction sheet and other formats that were utilized during the study.

CHAPTER TWO

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1. Introduction

Malaria is a parasitic infection caused by Plasmodium protozoa. *Plasmodium falciparum, P. vivax, P. ovale* and *P. malariae* are the four leading species of malaria parasites that cause malaria in human beings. *P falciparum* and *P. vivax* are the species that cause most of the world's malaria (UNICEF, 2007). *Plasmodium falciparum* is the commonest species causing malaria in Africa, whereas *P. vivax* infections are predominant in parts of Asia and Latin America (UNICEF, 2007). Malaria is the leading reason to hospital visit and death in Sub-Saharan Africa (WHO, 2015). In malaria prone settings, fever has been associated with malaria (Ezeoke et al., 2012). Efforts at controlling malaria seek to among other interventions reduce its burden through appropriate diagnosis (GHS, 2015).

2.2. State of Malaria and Interventions to Minimise Burden of Disease

In the year 2000, the number of countries and territories with malaria incidence was 106 (WHO, 2016). By the close of 2015, the number had decreased to 95 and European regions covered by WHO had zero indigenous incidences for the first time since WHO commenced tracking the disease (WHO, 2016).

According to WHO, Ghana, Democratic Republic of Congo, Burkina Faso, Niger, Mozambique, Cameroon, Cote D'Ivoire, Uganda, Nigeria and Tanzania contributed about 60% of the malaria deaths in Africa (Berg et al., 2012). Ghana is classified as a hyper-endemic area, putting every resident at risk for the disease (Fenny, Hansen, Enemark, & Asante, 2014). The Ghana Health Service note that, there were 10.4 million suspected malaria cases representing about 39% of all OPD cases. One fourth of all hospital admission and 4% deaths were attributable to malaria.

About 47% of the deaths (590) reported on children under age five was caused by malaria (GHS, 2016).

According to Ghana's National Malaria Control Programme (NMCP), *Plasmodium falciparum* species causes the most severe malaria (NMCP, 2013). The species causes 80 to 90% of malaria cases in Ghana, followed by *P. malariae* (10 to 20%) and *P. ovale* (about 1%) whereas P. *vivax* has not been recorded in Ghana(NMCP, 2013).

The purpose of the Abuja Declaration 2006 was aimed at achieving a global access to the appropriate interventions to malaria (Fenny et al., 2014). In light of the above declaration, malaria control programmes in Ghana targeted at decreasing malaria burden to 75% by 2015 (Fenny et al., 2014). Through the use of insecticide treated bed nets, indoor residual spraying, intermittent preventive measures in pregnancy, more than 700,000 deaths were believed to have been prevented in Africa (WHO, 2011c). The use of parasite based diagnosis, timely detection and appropriate treatment of malaria are vital in the prevention and control of malaria, especially among pregnant women and children aged below five years (Abreha et al., 2014; Boadu et al., 2016). The introduction of long lasting insecticide treated bed nets, Artemisinin-based Combination Therapy (ACT), and malaria rapid testing kits have collaboratively contributed to reduction in malaria incidence globally (Stresman et al., 2012)

2.3 Malaria Diagnosis and Rapid Diagnostic Testing

According to the Ministry of Health, diagnosis is the first step in the management of malaria case (MOH, 2014). Correct and timely diagnosis is very crucial for effective management of malaria (Tangpukdee, Duangdee, Wilairatana, & Krudsood, 2009). Acceptable diagnosis of malaria involves identifying the plasmodium parasite or component in the human blood (Tangpukdee et al., 2009; UNICEF, 2007). Ghana aims at diagnosing all malaria cases using microscopy or RDT as part of measures to ensure malaria is well managed and resources are well used (GHS, 2018).

That notwithstanding, WHO African Region is yet to achieve 100% parasite based diagnosis of malaria (WHO, 2018). Whereas the WHO African Region had attained about 87% testing rate by 2016(WHO, 2018), the Ghana Health Service recorded 77.3% (GHS, 2016) rate, lagging behind other African states in the quest to get all cases tested. Ezeoke and colleagues in 2012 found out that presumptive treatment of cases was based on clinician's judgement at the expense of testing.

Malaria RDTs were made to assist in getting all suspected malaria cases diagnosed in areas where microscopy services are not affordable or may not be suitable (WHO, 2018). Such areas may include remote testing areas far away from microscopes, in emergency situations or areas such as malaria risk mining grounds (WHO, 2018). Under conditions such as above or where there is pressure on the microscopes or the laboratory is closed, the Ghana Health Service advocates for the use of malaria RDTs to augment blood film use in the diagnosis of malaria (GHS, 2015).

2.4. Types and quality of Malaria RDTs

Three basic groups of malaria RDTs are: *Plasmodium falciparum* histidine-rich protein-2 (HRP-2); Plasmodium lactate dehydrogenase (pLDH); and Adolase detecting rapid diagnostic test kits (Mouatcho & Goldring, 2017; UNICEF, 2007).

2.4.1. Plasmodium Falciparum Histidine Rich Protein 2 (PfHRP2) Detecting RDT

Three histadine rich proteins discovered are *Pf*HRP1, *Pf*HRP2, and *Pf*HRP3 (Mouatcho & Goldring, 2017). *Pf*HRP1 is associated with the exoskeleton of red blood cells that have been infected with *P. falciparum* (Mouatcho & Goldring, 2017). HRP2 can be recognized in all *P. falciparum* infected red blood cells irrespective of knob phenotype making it a preferable marker of the *P falciparum*. "PfHRP3 has histidine rich amino-acid repeats regions, is secreted by P.

falciparum parasites and is recognized by some of the monoclonal antibodies detecting PfHRP2 in RDTs" (Mouatcho & Goldring, 2017).

Presently, majority of the commercially accessible malaria test kits are *Pf*HRP2 detecting RDTs (GMP, 2016). Because of the strong similarity between the amino acid sequence of *Pf*HRP2 and *Pf*HRP3, the antibodies on the testing device may "cross-react" with *Pf*HRP3 in the bloodstream of the infected person (GMP, 2016). The general preference for *Pf*HRP2 detecting RDTs is because of its resistance to heat and sensitivity compared to other RDTs (GMP, 2016).

The engineering process of RDTs actually affects the variability in sensitivity and specificity (WHO, 2011b). Sensitivity is the percentage of positive tests as reported by the screening kit/procedure among the overall positives as reported by the gold standard diagnosing kit/procedure (Mouatcho & Goldring, 2017). Likewise, specificity is the percentage of negative tests among the total actual negative samples (Mouatcho & Goldring, 2017). In malaria diagnosis, the gold standard is either microscopy or polymerase chain reaction (PCR) (Mouatcho & Goldring, 2017).

Variability in the amino acid sequence of the parasite's HRP2 from different geographical locations is one of the reasons of false-negative in RDTS. Baker and colleagues (2005), discovered that there was a significant structural difference HRP2 of isolated parasites from 19 countries (Mouatcho & Goldring, 2017). Notwithstanding, it has been found that extreme sequence disparity was not a major cause of the differing sensitivity and specificity in malaria RDTs (Baker et al., 2010). In Peru, a study discovered large scale absence of the HRP2 in parasites(Gamboa et al., 2010) This genetic alteration was confirmed as a major cause of failure of RDTs producing false-negative results (Berhane et al., 2017). In light of emergence of genetic variations and deletions, RDTs that target other proteins need to be used to complement HRP2

RDTs in affected countries (GMP, 2016). In addition, persistence of *Pf*HRP2 even after treating the infection has been recorded in many studies (Mouatcho & Goldring, 2017). False positive can also be caused by *Schistosoma mekongi* infestation (Leshem et al., 2011).

2.4.2. Plasmodium Lactate Dehydrogenase (pLDH) RDTs

Lactate Dehydrogenase (LDH) is a vital energy-producing enzyme (Mouatcho & Goldring, 2017). The soluble enzyme is secreted by all stages of the plasmodium species that infect humans, sexual and asexual (GHS, 2018). Plasmodium (the parasite) and red blood cell (the human host) lack a complete citric acid cycle for mitochondrial ATP synthesis and rely on anaerobic glucose metabolism (Mouatcho & Goldring, 2017). The pLDH is thus an important enzyme for the production of energy in the plasmodium organism. Although pLDH possess 26% amino sequence similar to human LDH, it has preserved catalytic deposits for enzyme activity and share >90% amino acid identity among all the species of plasmodium (Mouatcho & Goldring, 2017). LDH test kits can detect and differentiate all the species of malaria (Mccutchan, Piper, & Makler, 2008).

Even though pLDH kits in the Ghanaian settings can only detect LDH specific to *P. falciparum*, other forms can be engineered to detect other species of plasmodium (GHS, 2018). With the use of pan pLDH RDT, the issue of not detecting a non-falciparum malaria species is addressed (Piper, Buchanan, Choi, & Makler, 2011). Unlike HRP2 targeting RDTs, LDH does not persist in the bloodstream after the infection has been treated (Gerstl et al., 2010). pLDH is used for a drug sensitivity test making it "a good marker for monitoring parasite responses for treatment and for predicting treatment failure" (Mouatcho & Goldring, 2017). The protein does not undergo antigenic modifications (Talman et al., 2007) and also does not exhibit prozone effect, a phenomenon where false negative/low results are recorded in an immunological testing (Gillet, Mori, Esbroeck, Ende, & Jacobs, 2009).

However, LDH detecting kits have some shortcomings. At low parasite density, they perform poorly (Heutmekers et al., 2012; Jang, Cho, Han, An, & Lim, 2013). This could be attributed to the presence of relatively large quantity of protein (Mouatcho & Goldring, 2017). Because pLDH is expressed by gametocytes of plasmodium, high gametocytaemia can result in false positive (Mueller, Betuela, Ginny, Reeder, & Genton, 2007). Compared with HRP2 detecting RDTs, pLDH RDTs can poorly withstand heat (GMP, 2016). They are reported to be more costly comparatively (GHS, 2018). That notwithstanding, the third WHO/FIND investigations found that pLDH-based RDTs competed well with PfHRP2 RDTs (Ashton et al., 2010).

2.4.3. Aldolase Detecting Malaria RDTs

Aldolase is an enzyme involved in glycolysis of many of the tissues in the malaria parasite and human host. The protein is soluble in the parasite (UNICEF, 2007). Aldolase functions as a catalyst during the formation of dihydroxyacetone phosphate and glyceraldehyde-3 phosphate from a sugar 1,6-bisphoshate (Mouatcho & Goldring, 2017). There is only one kind of aldolase specific to a tissue found in *P. falciparum and P. vivax* whereas there are three in higher animals (Kim et al., 2012).

Aldolase is produced by all the plasmodium species known to cause malaria yet, aldolase kits have been seen to be least sensitive (GHS, 2018). Compared with HRP-2 detecting malaria test kits, studies about aldolase RDTs are minimal (Mccutchan et al., 2008). Aldolase/HRP2 RDTs have been made to detect both *P. falciparum* and *P. vivax* (Mccutchan et al., 2008; UNICEF, 2007). Although WHO/FIND found aldolase to withstand heat well (Mouatcho & Goldring, 2017), Ashton and colleagues found the enzyme's resistance to heat to be poor (Ashton et al., 2010).

2.5. Use of test results

The adoption of RDT to supplement blood film was expected to improve malaria case management (GHS, 2017). Yet, compliance with RDT results is still a challenge (Ansah-koi, 2016). Patients are prescribed antimalarial despite testing negative (Kyabayinze et al., 2010). About a third of negative RDT results that exhibited elevated temperature were found to be administered antimalarial (Kyabayinze et al., 2010).

Mistrust of RDT results is the main culprit behind noncompliance, especially when RDT results are negative. Clinicians may do so to satisfy clients (Ezeoke et al, 2012). Other reports indicate that some providers elsewhere were very compliant (Kyabayinze et al., 2010). In two separate districts where the studies were undertaken, 100% and 99.4% of negative RDT cases were not given antimalarial suggesting that when other healthcare providers are given enough sensitization and support, compliance will be enhanced and patient interruptions will be minimized or dealt away with. Continuous noncompliance is a setback to effective malaria control (Kyabayinze et al., 2010).

2.6. Health system factors affecting the use of malaria RDTs

Challenges that have been reported with the use of RDT in malaria diagnosis include training of staff, RDT quality assurance checking, packaging, transportation and storage of RDT (Mouatcho & Goldring, 2017), incomplete health system capacity, provider perception, poor provider involvement in policy making (Boadu et al., 2016), mistrust for investigation results, financial difficulties (Ezeoke et al., 2012) and lapses in RDTs procurement and supply (Bruxvoort, Kalolella, Nchimbi, Festo, & Taylor, 2013).

The World Health Organization identified the following bottlenecks in RDT and ACT procurement and supply chain management: Delay in release of funds; inefficient logistic management information system; poor buffer stock; delays in customs clearance and product distribution to the peripherals; deprived in country infrastructure and; insufficient storage facilities (WHO, 2017). In an exploratory study to find the factors that affect the use and performance of malaria RDT in Limpopo, South Africa it was found that a third of facilities did not have air-condition in their stores and half of respondents complained of stock-outs (WHO, 2017).

Despite WHO recommendation for the implementation of a quality control checking of RDTs (Cunningham, 2014), many malaria endemic regions, do not have or have limited systems in place for the practice (Boadu et al., 2016; Ezeoke et al., 2012; Mouatcho & Goldring, 2017). According to Harvey and colleagues, the ability to decipher instruction manual in RDTs have the potential of adversely affecting the outcome of the quality of testing and accuracy (Harvey et al., 2008). In an area where malaria is not endemic, Gillet and other scholars found out that faults in RDT performance were mostly as a result of test-line interpretation, somewhat because of incorrect inserts in the boxes of the kits (Gillet et al., 2010). Training of health personnel, especially those directly using malaria RDT to diagnose is very essential in targeting the problem of inaccurate interpretation of results (Mouatcho & Goldring, 2017). Since different countries have different treatment guidelines for the treatment of malaria, training must be contextualized and made to teach health personnel "problem solving skills" (Mouatcho & Goldring, 2017)

2.7. Patient factors affecting RDT use for testing malaria

Age, sex, occupation, education among other socio-economic factors have been found to be associated with malaria infection, RDT use and compliance to test results.

In a Rwandan setting, a cross sectional study revealed that RDT test was preferred to blood film in households with low level of education, low monthly income, with community based health insurance when Community Health Worker used it for reason of cost (Misbah, Habtu, Mochama, Kansiime, & Asiimwe, 2017). The, people were found to prefer RDT type that can detect all species (Misbah et al., 2017). In a Nigerian setting, the urban dwellers were more willing to pay for RDT services (Uzochukwu, Onwujekwe, Uguru, Ughasoro, & Ezeoke, 2010).

In a study conducted in a Ghanaian setting, the age and measured temperature of patients among other prescriber and health facility characteristics were seen to influence treating according to results of the test(Asamoah, 2014). Patients older than 45 years were 50% more likely to receive complied treatment (Asamoah. 2014).

2.8. Perceptions of Malaria RDTs

Many studies have confirmed the reliability of malaria RDTS (Ansah-Koi, 2016). The perception of healthcare providers affects their adoption of policy guidelines on a health problem (Mubi et al., 2013). In Nigeria, it was found that negative perception of the malaria RDT had adverse effect on availability and utilization of the kit (Ezeoke et al., 2012).

Perception also has influence on adherence to test results. Danquah et al., (2016) found an association between a person having elevated temperature and the thought of them having malaria. In settings where elevated body temperature has historically been presumptively diagnosed malaria, an RDT that produces a negative test in fever situations may lose the trust of the locals (Miller, & Sikes, 2015). In a qualitative study in a Ghanaian district, respondents were of the view that not treating malaria when a person presents with fever was risky given that the Ghanaian setting is high risk area (Boadu et al., 2016). According to studies, patients desire to be tested for malaria before treated whereas test results may not have significant impact on prescription practices of healthcare providers was documented (Derua et al., 2011).

2.9. Theoretical Perspective

The theory of reasoned action (TRA; Ajzen and Fishbein, 1980) proposes that individual's behaviour is largely driven by the gravity of the intention of the person to perform that behaviour (Schiavo, 2007; University of Colorado, 2019). Two major factors (a person's attitude toward the behaviour and their subjective norms about the behaviour) constitute the intention of the person (Schiavo, 2007).

A person's attitude toward a behaviour is their harmful or helpful feelings or emotions towards the conduct, their perception or impression about that behaviour; whereas their subjective norms about a behaviour is the opinion or judgement that others such as loved ones, professional organizations, friends, comrades, or key influential people may have about it (Schiavo, 2007).

Under the TRA, attitudes toward a particular conduct are a function of the individual's beliefs about the consequences of that behaviour. These beliefs about consequences of behaviour are called behavioural beliefs (Schiavo, 2007; University of Colorado, 2019).

Subjective norms are inspired by normative beliefs, which refer to whether an individual may consider the approval or otherwise of significant externals (Schiavo, 2007). Key to a person's normative beliefs is their motivation to comply with others' viewpoint and possible approval or otherwise (University of Colorado, 2019).

In the context of this study, the behaviour of interest is use of malaria RDT in the diagnosis of malaria. Institutional factors such as awareness and knowledge of past and current policy guidelines, and health system factors such as perceptions, work experience and training of staff form the provider's subjective norms and their attitude respectively. It must be noted that factors such as availability of the RDT kit (health commodity supply) among other external factors play vital role in utilization of the malaria RDT kit.

2.10. Conceptual Framework

Based on the reviewed literature and the theoretical framework, the study was conducted based on the conceptual framework below:

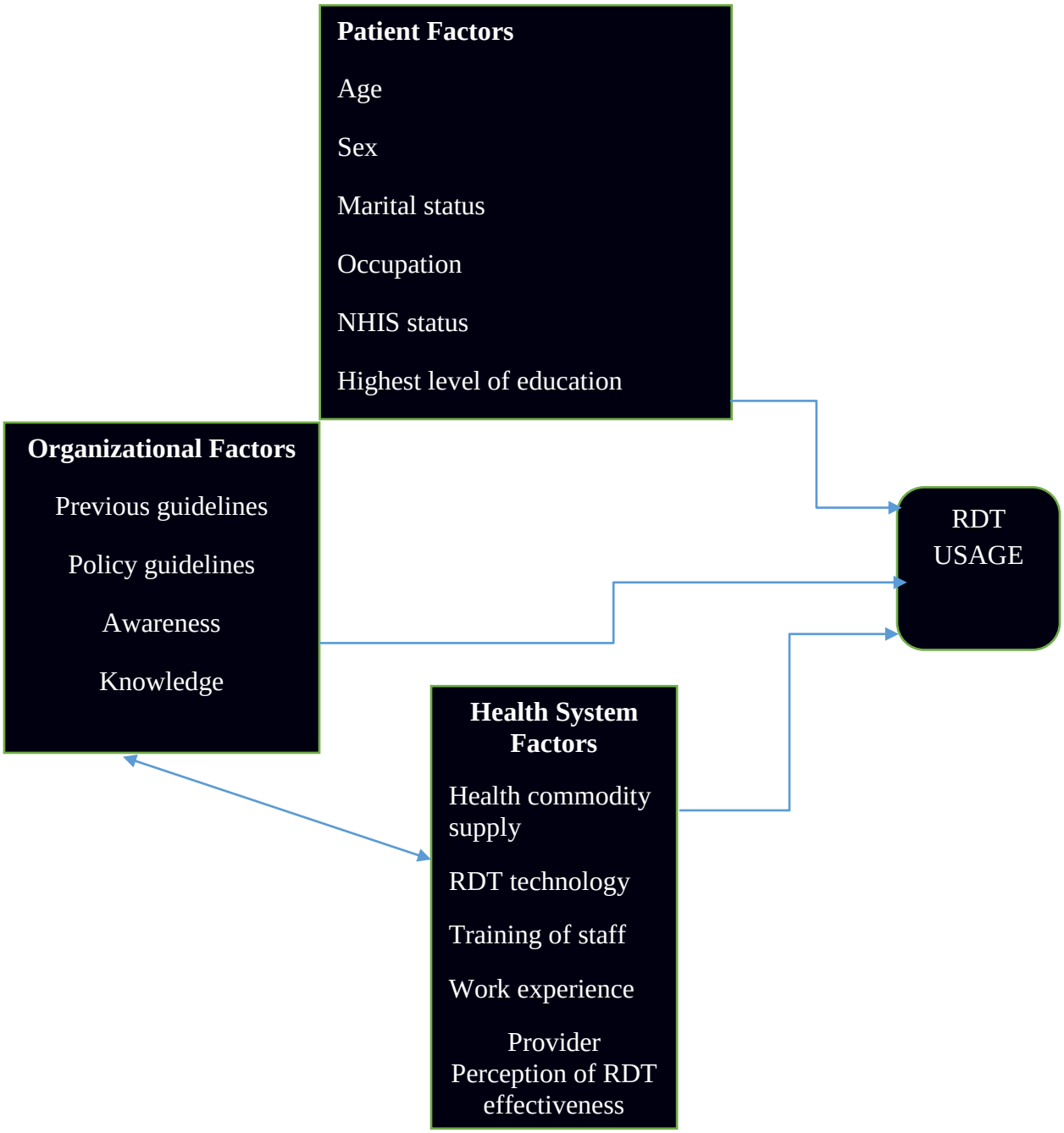

Figure 2.1: Conceptual framework for exploring healthcare providers' use of RDT kits in diagnosing and treating malaria. Source: Adapted from Boadu et al. (2016).

Patient factors such as insurance status, age, highest level of education and occupation of a patient affect their utilization of malaria RDT when they report to the facility and are suspected of suffering from malaria. Age is an important patient factor with regards to the use of malaria RDT (Asamoah. 2014; Boadu et al, 2016). Education, income and insurance status have among other socio-demographic factors of patients were found to affect their use of malaria RDT (Misbah et al., 2017).

Historical factors such as, previous and existing policy guidelines, awareness and knowledge also affect malaria RDT use (Boadu et al., 2016). Current and past policies on any medical device or kit do affect that kit's usage (Boadu et al., 2016). The 3T policy that ensures that all suspected malaria cases are tested before treatment and treatment strictly adheres to test results compel health professionals to use the malaria RDT kit or microscopy, which is the gold standard diagnostic tool.

Health system/provider factors including but not limited to provider perception, RDT technology, and health commodity supply all influence the use of malaria RDT. A positive perception about the RDT kit will definitely positively affect adoption of the malaria RDT use. The quality of the engineering of the malaria RDT kit also affects its adoption and use. A high quality but affordable RDT kit will boost malaria RDT use. Affordability thus is another important health system factor that affect RDT use. Historical factors and health system factors affect each other.

2.11. Chapter summary

Chapter two presented the literature reviewed to answer the research question. Literature reviewed included: State of malaria and interventions to minimize burden of disease; Malaria

diagnosis and rapid diagnostic testing; Types and quality of malaria RDTs; Compliance; Conceptual framework; Health system factors; Patient factors affecting malaria RDT use; and, Perceptions of malaria RDTs. Chapter Three describes the methods used in the study.

CHAPTER THREE

METHODS

3.0. Introduction

This chapter describes the study area, study participants, design, and approaches used in collecting information to assess the factors associated with the use of malaria RDTs in health facilities in Obuasi, Ghana. Data processing and analysis, quality assurance, ethical issues and dissemination of results have also been described ending with a chapter summary.

3.1. Study Design

The study applied a retrospective cross sectional design in the selection and use of patients' folders to establish the association between patient factors and use of RDT kits to test for malaria while semi-structured interviews were applied to collect data from the health providers on the health system and provider factors influencing the use of RDT kits for testing malaria at the health facilities. Thus, the study applied a mixed methods approach in the data collection.

Cross-sectional study is a type of descriptive study conducted to learn about particular characteristic(s) of a population at a point in time to produce estimates of that population characteristic of interest (Howick, 2002). A retrospective study is one whose outcome has already occurred before the start of the study (Kalogeropoulos, 2014).

3.2. Study Area

The study was conducted in the Obuasi Municipality of the Ashanti Region of Ghana with a population of 16,864. Obuasi is located between latitudes 5 º35N and 5 º65N, and longitudes

6º35'W and 6º90'W. It covers a total land area of 220.7 square km. It is located in the South-Western part of the Ashanti Region. It is 64 kilometres from Kumasi, the regional capital. The neighbouring districts of the Obuasi Municipality are Upper Denkyira (on the southern part of the municipality and located in the Central Region), Adansi North (north), Adansi South (east) and Amansie Central (west) , all in the Ashanti Region (Ghana Statisticial Services, 2014).

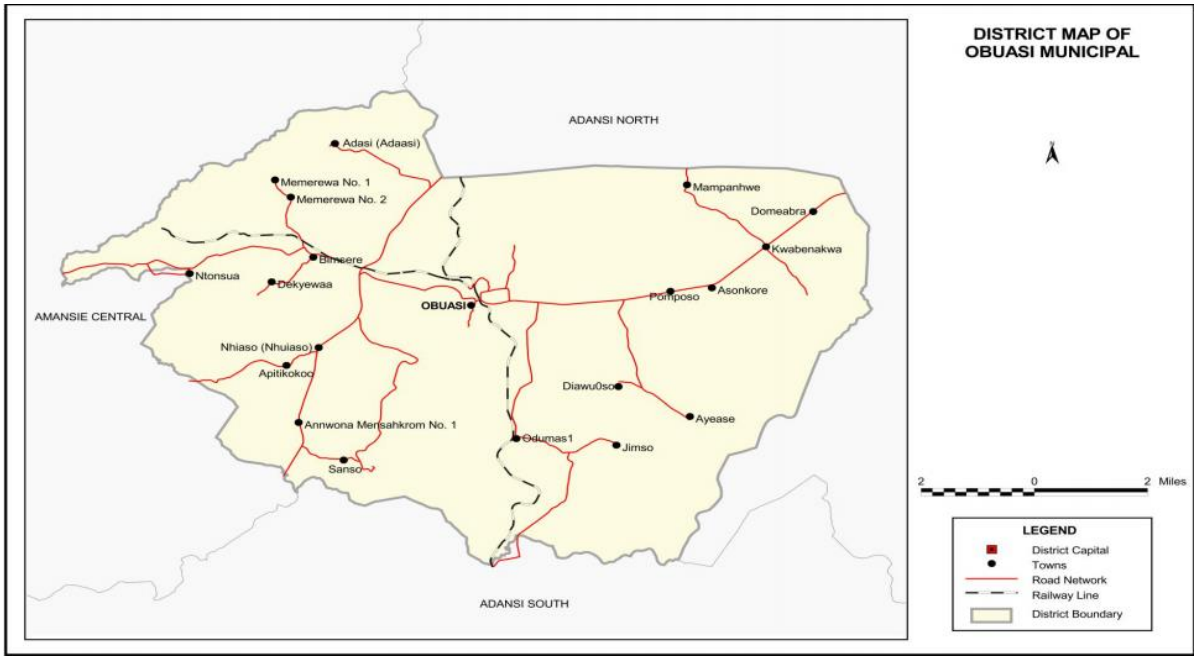

Figure 3.1: Map of Obuasi Municipal. Source: Ghana Statistical Services (2014).

There are nineteen health facilities in Obuasi. Of these, only four are government owned. Three are mission and the remaining twelve are privately owned. There are eight hospitals, four clinics, three maternity homes, two health centres and two Community-based Health Planning and Services (CHPS) compounds. All the eight hospitals together with three of the clinics and one maternity home, making a total of twelve facilities offer microscopy services (OMHD,2017).

Secondary data at the five selected health facilities were studied. These facilities had both RDT and microscopy services. Hospitals to be included in the study are Obuasi Government Hospital (in the Gausu Sub-Municipality), Bryant Mission Hospital (Tutuka), Todah Hospital (Brahabebome), AGA Health Foundation (Kwabrafoso) and St. Jude Hospital (New Nsuta).

3.3. Study Population

The study included a secondary data on individuals suspected of malaria in the OPD registers of the five selected health facilities in the month of June, 2017. June was selected because it is a period that malaria usually peaks as a result of change in rainfall patterns.

3.3.1. Inclusion Criteria

All uncomplicated malaria cases reported in OPD registers of the five health facilities for the month of June 2017 in the five sub-municipalities of Obuase, namely Obuasi Government Hospital (in the Gausu Sub-Municipality), Bryant Mission Hospital (Tutuka), Todah Hospital (Brahabebome), AGA Health Foundation (Kwabrafoso) and St. Jude Hospital (New Nsuta) were included in the study

3.3.2. Exclusion Criteria

Tested cases in the laboratory register for which information could not be found in the consulting room register; severe malaria cases; patient folders which were in use by their owners as at the time of data extraction and folders which did not bear all sought information were excluded from the study.

3.4. Sampling Procedures

Multi-stage sampling methods were adopted for the quantitative data collection. These included the use of simple random sampling method for selection of patient folders that were used in the quantitative data analysis while purposive sampling was applied to select the health facilities and providers interviewed in the qualitative study. These have been explained below.

Simple random sampling

With simple random sampling, all members of the population have equal chances of being selected and is most useful when population is relatively small (Sullivan, 2012).

Number of patient folders (of those tested for malaria) to be recruited for each selected health facility was calculated with respect to size of malaria cases referred for testing in the laboratory for the month of June, 2017. Folder numbers (OPD numbers) from the laboratory register were taken using random sampling after apportioning proportions of study participants among the five health facilities. These moves were to ensure that selected participants were representative and proportionate of each facility which is a prerequisite for reliance on quantitative data (Teddlie & Yu, 2007).

Five health facilities were selected to represent all the five sub-municipalities of the Obuasi Municipality. For each health facility, the folder numbers of all patients tested for malaria for the month of June 2017 was written on pieces of paper and folded. The required samples were drawn by trained research assistants by hand singly and randomly. The folders of all selected patients were assessed and scrutinized to fill data extraction sheet with variables such as patient age, marital status, occupation, level of education, insurance status, type of diagnostic tool used, test result and the type of treatment administered to the patient. Folders of patients for each facility were determined using information on number tested as included in Table 3.1 below:

Table 3.1: Characteristics of selected facilities

Facility Name	Type of authority	Sub-Municipality	Malaria Tested(June 2016)	Selected Participants
Obuasi Government Hospital	Government	Gausu	940	79
AGA Health Foundation	Private	Kwabrafoso	1825	153
Bryant Mission Hospital	Mission	Tutuka	934	78
Todah Hospital	Mission	Brahabebome	290	24
St. Jude Hospital	Private	New Nsuta	373	31

Purposive sampling method

Purposive sampling was useful with qualitative and quantitative research approaches (Tongco, 2007). The integral bias of the method adds to its effectiveness, and the method remains reliable even when compared with random probability sampling (Tongco, 2007). Purposive sampling was adopted to ensure that health providers and facilities with the heavy patient turnout in all the sub-municipalities were selected to be involved in the study so as to reveal the usefulness of RDT kits in diagnosing malaria RDT in these busy facilities.

3.4.1. Sample Size Calculation

In a similar study involving a secondary data review to determine the proportion of suspected malaria cases that was tested for, sample size for selection of patient records was done (Ansah-koi, 2016). Although the quantitative aspect of the study involved secondary data and therefore all patients who fell within the inclusion criteria could have been enrolled, constraints (such as limited resources and busy nature of the patient folders and hospital staff), necessitated a sample to be drawn from among the patient folders that qualified for the study.

Using Cochrane's formula for proportion ($n= Z^2pq/e^2$), sample size for the quantitative aspect of the study was calculated. The sample size, n as in the above formula was calculated using p, proportion of OPD cases suspected of malaria for the year 2016. According to WHO, proportion of individuals suspected of having malaria and tested has improved from 36% in 2010 to 87% in 2016 in the WHO African Region(WHO, 2018). To obtain the minimum required sample size with power, the proportion of OPD cases which was suspected of having malaria according to the Ghana Health Service which is 39% in 2016(GHS, 2017), was used. Therefore, p=39%=0.39.

q=1-p=1-0.39=0.61

Z=1.96 at confidence interval of 95%

e is the margin of error of 0.05

Thus $n=1.96^2(0.39*0.61)/0.05^2=365$

Therefore, 365 was the sample size for the study.

3.5. Study Variables

The variables measured in the quantitative study with respect to the use of the patients' folders have been explained below.

3.5.1. Dependent variable(s)

The dependent variable in the study was as below:

Use of RDT kits for testing and diagnosing malaria

3.5.2. Independent Variables

The independent variables in the study were as below:

- Diagnostic tool
- Test result
- Treatment type.
- Patient factors: Age, sex, marital status, occupation type, NHIS status, educational background

These have also been defined and the measurement scale used have been presented in table 3.2 below:

Table 3.2: Definition of variables and their scale of measurement

Variable	Operational Definition	Type of variable	Scale of measurement
Diagnostic tool	The type of diagnostic tool for testing malaria	Independent	Binary: RDT/BF
Treatment type	The type of treatment given a person tested for malaria	Independent	Binary: Antimalarial/Other
Test result	Result of malaria test	Independent	Binary: Negative/Positive
Age (patient)	Age in years at last birthday of patient	Independent	Discrete
Sex (patient)	The sex of patient	Independent	Binary: Male/Female
Marital status (patient)	The marital status of patient	Independent	Binary: Married/Not married
Occupation type (patient)	The type of occupation of patient	Independent	Categorical: Unemployed/ Formal/Informal/ Student or Apprentice
NHIS status(patient)	The insurance status of patient	Independent	Binary: Non-insured/Insured
Education (patient)	Highest level of education of patient	Independent	Categorical: none/basic/ secondary/tertiary

Source: Researcher's Conceptualization (2018).

3.6. Data Collection

Two methods were applied to collect data for analysis. Data collection was done from August to September, 2018. Both quantitative and qualitative methods were applied as explained below.

3.6.1. Quantitative Data Collection

Although questionnaires were not administered to patients in the quantitative methods, a retrospective cross-sectional design was applied to collect data from folders/records of patients (Secondary data) who tested for malaria in June 2017. Quantitative research is a kind of research that describes phenomena by representing observations with numbers for statistical analysis (Sukamolson, 1998). Quantitative approaches were adopted to find proportion of patients who

were tested for malaria using RDT and also to determine patient factors of patients tested for malaria using RDT.

Data extraction sheet bearing all the quantitative variables was designed by the researcher using Excel spreadsheet and printouts from these were given to research assistants after they had been trained for a day on sample taking. After the researcher assigned the number of patient folders to be included for each facility, the OPD numbers of the patients tested were written on pieces of blank sheet using the laboratory and OPD registers and folded into a bowl. The research assistants drew out randomly from each bowl till the required number for each facility was reached. Selected patients' information such as age, sex, insurance status, test results, type of tool used to diagnose malaria were recorded on the data extraction sheet manually from the patient folders. Data from the laboratory and consulting room registers were compared with information retrieved from the folders to ensure they marched. The data was later transferred to an Excel spreadsheet for analysis.

3.6.2. Qualitative Data Collection

The qualitative research method was applied where semi-structured interviews were used to explore the perceptions of purposively selected healthcare workers of malaria RDT kits in health facilities in the municipality. Qualitative research is a form of study that investigates information not contained in quantitative data and borne via language and behaviour in a natural environment (Berkwits & Inui, 1998). Information about viewpoints, values, feelings and motivations underlying malaria RDT used to test results were captured using qualitative approach. A purposive sampling was used to recruit some health prescribers, biomedical scientists and other public health officials in the selected health facilities, officials from the Obuasi Municipal Health Directorate and the Anglo-Gold Ashanti Malaria Control Programme to explore their perceptions

of the availability and use of malaria RDTs. This type of non-probability sampling technique was used because selecting the purposive sample is the fulcrum of the quality of data gathered; consequently, trustworthiness and competence of the informant is assured (Tongco, 2007).

Purposively selected health workers were interviewed using a semi-structured interview guide. To select the staff members who had to be interviewed included from every facility, the unit/department head was consulted on who, when and where (within their facility) the interview was to be done. The researcher was the interviewer for all the interviews. A tape recorder was used to record every conversation besides a research assistant taking notes using a book. For all the laboratory staff interviewed, the office within the laboratory was used for the interview. For all prescribers, the consulting room was used. The two officers from the OMHD and AGA Malaria Control Programme interviewed also permitted the interview to be conducted in their offices. The interviewer engaged an eye contact with the interviewees throughout the undertaking. Duration of the interviews ranged from 30 to 50 minutes.

3.7. Data processing and analysis

Different strategies were applied to analyse the data obtained. These have been described below.

3.7.1. Quantitative Data Analysis

Data collected were entered unto a Microsoft Excel sheet and coded. To ensure accuracy of the data, it was cross-checked by the research assistant(s) and the researcher. Data was then imported into Stata Version 15.0 for analysis. The socio-demographic information of patients, type of tool used to test patients, test results and treatment received among others, were represented in a table. The ages of the patients were regrouped as: Below 5 years, 5-12 years, 13-45 years, 46-60 years and 60+ years. The proportion of patients tested using RDT as against

blood film, patient factors, and the association between diagnostic tool and treatment type (using Chi square test of association) were expressed in percentages and displayed using bar graphs.

3.7.2. Qualitative Data Analysis

Since a semi-structured interview guide was used to interview the health professionals, information from the discussions and interviews were analysed thematically. Two main themes explored included health system factors and historical factors influencing the use of malaria RDT and test results. Health system factors covered areas such as types of malaria RDT kit being used, health worker training in the use of malaria RDT, suitability of RDT, perceptions of health workers, challenges regarding use of malaria rapid diagnostic test and knowledge of *Pf*HRP2 gene deletion. The audio recorded voices were translated using a Microsoft Office Word text. The data was coded and categorised into thematic domains. This enabled the summary data to be manually sorted and gathered based on the above mentioned themes such as perceptions of RDT, knowledge of *Pf*HRP2 deletion and challenges in the use of RDT and historical factors influencing the use of malaria RDT. Codes were used to identify the interviewees when quoted.

3.8. Quality Assurance

Credibility in qualitative research ensures ethical considerations and getting findings the way they really are (Ansah-Koi, 2016). Triangulation of sites, audit trail and peer debriefing, as used in the aforementioned study, were used to ensure quality in the qualitative research. Although all the selected facilities had RDT and microscopy services, the atmosphere under which they operated differed. Thus, private, mission and government clinics/hospitals were all included in the study to ensure multiple settings. Audit trail included comprehensive field notes, memos and documentation of steps taken before arriving at a decision. Supervision of academic advisors

such as main research supervisor, lecturers in the Department of Health Policy, Planning and Management in the School of Public Health, University of Ghana and the public health officials in the OMHD also ensured the quality of data collected. Research assistants were trained prior to data collection and supervised by the principal investigator during the quantitative data collection.

3.9. Ethical Considerations

The needed ethical activities were ensured in the conduct of studies involving human subjects and in health facilities in Ghana. These have been explained below.

Ethical clearance

Ethical approval was granted by the Ethical Review Committee of the Ghana Health Service (GHSERC). The letter was referenced: GHS-ERC053/01/18.

Letter of introduction

A letter of introduction written by the Head of Department, Health Policy, Planning and Management, School of Public Health, College of Health Sciences, University of Ghana, was sent to the management of the selected health facilities.

Confidentiality / Privacy

Informed consent was obtained from the purposively sampled participants involved in the qualitative study and confidentiality/privacy was assured before their engagement in the study.

Risks and benefits

Participants in the qualitative study were informed about the purpose, procedures, risks, and benefits of participating in the research.

Conflict of interest

Qualitative study participants were assured that the researcher had no conflict of interest in the study. The participants were however informed of possible minor discomforts in answering certain questions for which they could choose not to answer.

Voluntary participation

Only participants who agreed to be part of the study were recruited and required to sign or thumbprint a consent form as an indication of their willingness to participate (see Appendix A). Participants were informed that participation in the study was voluntary and they could withdraw at any time without attracting any penalty.

Dissemination of Results

The research findings were presented to the School of Public Health, College of Health Sciences. Copies were to be kept at the University of Ghana Library for other students to access. Copies were sent to the management of the five hospitals. Furthermore, the findings would be presented at key scientific conferences and meetings in Ghana as well as international conferences. Manuscripts would be prepared for publication in peer-reviewed scientific journals related to the field of study.

3.10. Chapter summary

This chapter described the methods used in the study. A mixed methods approach using qualitative and quantitative methods was adopted in collecting data for analysis. Data collection was done from August to September, 2018. In the quantitative method, retrospective secondary data of patients tested for malaria (in five selected hospitals in the Obuasi Municipality, which offered microscopy and RDT services) in the month of June, 2017 were assessed. Interviews

were conducted with 13 purposively selected health providers involved in the use and supply of RDTs in the Obuasi Municipal Health Directorate and the aforementioned facilities to explore their perceptions, knowledge, challenges in the use of malaria RDT. The next chapter, Chapter Four, presents the results of the study.

CHAPTER FOUR

RESULTS

4.0. Introduction

This chapter presents the results as analysed from both quantitative and qualitative studies. Quantitative results presented are on proportion of patients tested using malaria RDT; demographic characteristics of patients tested for malaria using RDT and provider use of malaria RDT results. Qualitative findings are grouped in organizational factors and health system factors influencing malaria RDT use in health facilities in Obuasi.

4.1. Quantitative results

The results of the study as obtained from the analysis of the quantitative data are presented in this section.

4.1.1. Socio-demographic characteristics of patients

From Table 4.1, the results of the socio-demographic characteristics are presented. The age group 13-45 years had the highest number of responses, 188 (51.5%); and the 60+ years group had the least number of responses, 25(6.9%). Only 114 (31%) of participants were males and females were 251(69%). About 47% of the participants were employed. Of these, 78.7% were working in the informal sector. About 43 (12%) of the people tested for malaria were students or in apprenticeship and 148 (40.55%) were not employed. A 103 representing 28% of the participants were married. A number of 232 of the people tested for malaria in the study period representing 63.6% had had some level of formal education. 154 (66%) of these had only basic level of education. Insured participants were more than the non-insured. 95 people representing 26% were non-insured.

Table 4.1: Socio-demographic characteristics of respondents

	Frequency.	Percent
Age category		
<5years	72	19.73
5-12years	40	10.96
13-45years	188	51.51
46-60years	40	10.96
60+	25	6.85
Sex		
Male	114	31.23
Female	251	68.77
Occupation		
Unemployed	148	40.55
Formal	37	10.14
Informal	137	37.53
Student/Apprentice	43	11.78
Marital status		
Not married	262	71.78
Married	103	28.22
Education		
None	133	36.44
Basic	154	42.19
Secondary	41	11.23
Tertiary	37	10.14
NHIS status		
Non-insured	95	26.03
Insured	270	73.97

4.1.2. Proportion of patients tested for malaria with the use of RDT

The proportions of patients tested for malaria with the use of RDTs are shown in table 4.1 and figure 4.1. From Table 4.2, about 89 (24%) of the respondents were tested for malaria using RDT only; 158 (43%) were tested using both RDT and BF; while the remaining 118 (32%) were tested using BF only.

Table 4.2: Proportion of RDT, BF and Both (RDT and BF) tools usage

	Frequency	Percent (%)
Tool		
BF only	118	32.33
RDT only	89	24.38
Both(BF and RDT used simultaneously)	158	43.29

Source: Field Data (2018).

From Figure 4.1 below, the number of patients tested using only BF is 118 and only RDT 89. Therefore, proportion of suspected malaria cases that are tested using RDT is 43%.

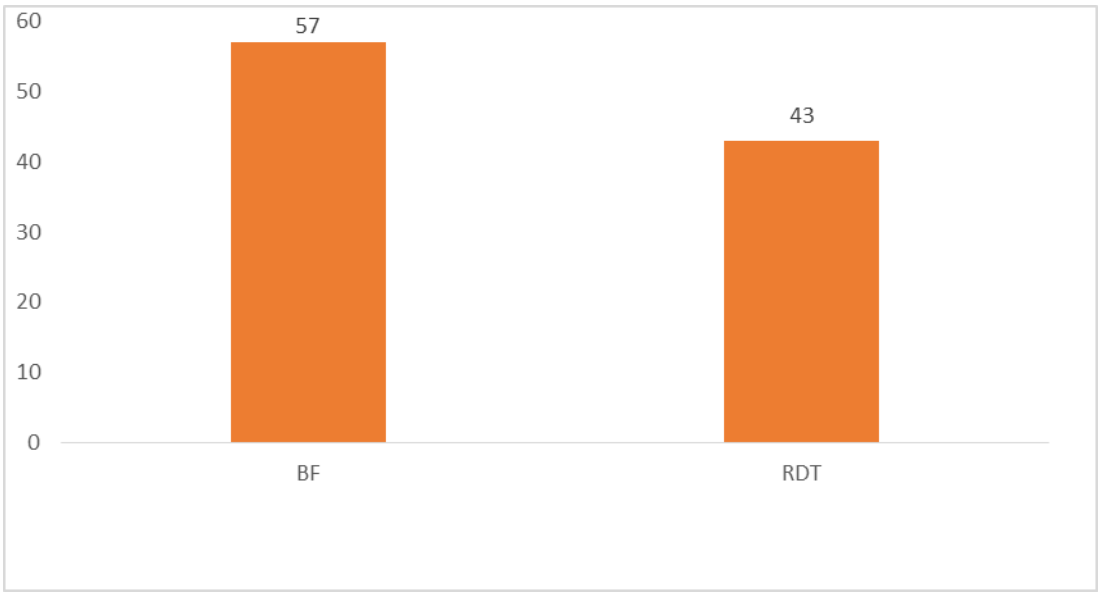

Figure 4.1: Proportions of BF and RDT usage. Source: Field Data (2018).

4.1.3. Test result, Treatment Provided/Received and Prescribers' use of RDT kits

Analysis of the patients' folders showed the test results, treatment provided and received by patients and the prescribers' use of RDT kits (described as treatment compliance) in such diagnosis as shown in Table 4.3. It would be seen that 103 (28%) of respondents tested positive to malaria and overall level of use of RDT kits was 94%. All positive cases were administered with antimalarial. Although 103 (28%) tested positive, 125 (34%) responded having received antimalarial treatment. The results showed that 22 (6%) patients were treated with antimalarial although they tested negative. Thus, they received non-treatment compliance.

Table 4.3: Test result, Treatment Provided/Received and Prescribers' use of RDT kits

	Frequency	Percent
Test result		
Negative	262	71.78
Positive	103	28.22
Treatment		
Other treatment	240	65.75
Antimalarial treatment	125	34.25
Treatment Compliance		
Noncompliant	22	6.03
Compliant	343	93.97

Source: Field Data (2018).

4.1.4. Prescribers' use of malaria RDT test results

Figure 4.2, shows results of the association between the diagnostic tool type and the level of use of the RDT test results. It was shown that the level of appropriate use was highest among those who were tested using both tools (95.6%) and least among those who were tested for malaria using only RDT (89.9%). Using Chi Square test of association to find relationship between

appropriate use of antimalarial and diagnostic tool type, it was seen that there was no statistical association (p>0.172). Thus although prescribers who have tested for malaria using both tools (BF and RDT) simultaneously were the least likely to inappropriately administer antimalarial (4.4%), followed by testing using only BF (5.1%) and the least testing using only RDT (10.1%), there was no statistically significant differences between the probabilities.

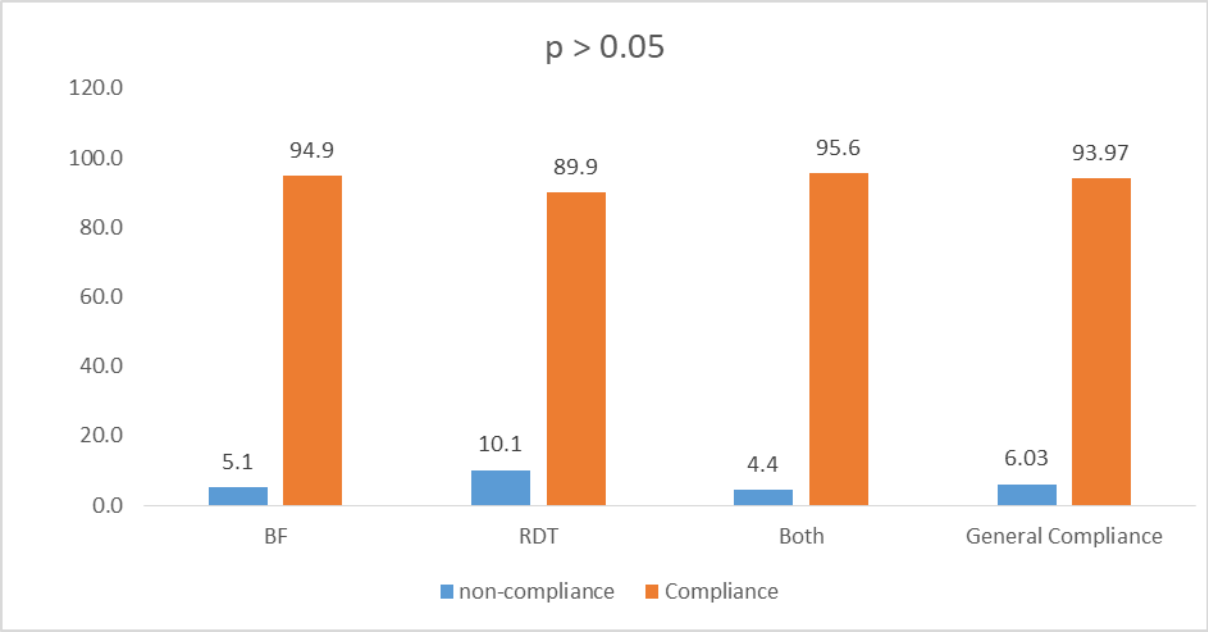

Figure 4.2: Prescribers' use of malaria RDT test results. Source: Field Data (2018).

4.2. Qualitative Data

The qualitative results as obtained from analysis of the interview data are presented in this section.

4.2.1. Health System Factors

Health system factors explored in this study covered areas such as background details of study participants, type (technology) of RDT used in facilities, training of health workers in the use of

RDT, perceptions of RDT kits, and suitability of RDT knowledge of health workers of *Plasmodium falciparum* HRP2 gene deletion.

Background Details of Interview Participants

The background details of the interviewees are shown in Table 4.56. Of the five hospitals purposively sampled to represent the various Sub-Municipalities, two were mission, one was government and remaining two were privately owned. Among the two privately owned, one was 'for profit' whereas the remaining one was 'not for profit'. Interviewees' years of work ranged from 2 to 14 years, 8 years being the median and also the mode work experience. It was found that only two of the interviewees were females. There were three medical doctors, two physician assistants, five medical laboratory scientists, one laboratory technician and two public health officers. Among the public health officers, one was a Monitoring and Evaluation Officer whereas the other was the Malaria Focal Person of the Municipality. One Medical Laboratory Scientist doubled as a member of the On-site Training and Supportive Supervision (OTSS) crew. There were two diploma holders, eight first degree holders and three post-graduate degree holders among the interviewees.

Table 4.6: Background Details of Interview Participants

	Frequency	Percent(%)
Type of facility		
Government	1	
Mission	2	
Private (Not for Profit)	1	
Private (For Profit)	1	
Work experience		
2 years	1	7.7
3 years	1	7.7
5 years	2	15.4
6 years	1	7.7

8 years	3	23
9 years	2	15.4
12 years	1	7.7
14 years	2	15.4
Sex		
Male	11	84.6
Female	2	15.4
Cadre		
Medical Officers	3	23
Physician Assistant	2	15.4
Medical Laboratory Scientist	5	38.5
Laboratory Technician	1	7.7
Public Health Officer	2	15.4
Education		
Diploma	2	15.4
First Degree	8	61.5
Postgraduate	3	23

Source: Field Data (2018).

4.2.2. Type of RDTs used in the facilities

A question was asked to ascertain the type of RDTs been used at the healthcare facilities involved in the study. It was noticed that all the five facilities were using HRP2/pLDH detecting RDTs supplied by the Municipal Health Directorate. The type of malaria RDT kit supplied to facilities depended on what was available at the Regional Medical Stores:

> *First the kits could detect only HRP2. We have been using the new type (HRP2/pLDH) for about 6 months now [MLS/OTSS Member]*

> *We don't have a say on the type of RDT. Normally, the Region supply us and so when we go, whatever is there, we take it [PHO]*

4.2.3. Training in the use of malaria RDT

All respondents with the exception of one prescriber, had had some formal training in the use of malaria RDT. Days of training ranged from one (1) to 14 days:

> "*I think the duration for the training for the RDT use was for like a day."[MO]*

> *"I had a week long training in the use of malaria RDT a couple of years ago."[MLS]*

> *"It was about both RDT and BF and some quality assurance. The training lasted about 14days or so." [MLS]*

4.2.4. Perceptions of malaria RDT kits

The analysis of the interview data revealed that perceptions of the study participants of RDT kits could be categorised into: perceptions about of the RDT kit itself and; perception about the policies of testing before treatment and adherence to use of the test results. These have been presented below:

Perceptions of the RDT kit

Perception of the study participants of the malaria RDT kit can be categorised into strengths and limitations of RDT kit. Participants described the strengths of the RDT kits in helping them to carry out the needed test on patients for purposes of malaria diagnosis. The following strengths were reported by respondents:

> *For as long as I have been aware of RDTs, we've come a long way as a malaria community with respect to RDT use... So I think that RDTs are good. They work. I think they are the future. These days they are very accurate as compared to some time ago. There are very small margins of error. We are sure if you test positive to RDT, the probability that microscopy will be positive is quite high. As a first line treatment of malaria, I am all for RDT [PHO].*

> *Yes it's easy to use and you can use it when there is no power compared to the microscopy where you need electricity to power it. It can also be used anywhere. At the OPD, anybody, any health worker who is trained in the use of RDT can use it. So you can use it on the wards. You can use it at the OPD. You can use it in the consulting room. But it should be used by those who have been trained [OTSS member/MLS]*

Despite the reported strengths of the RDT kit, the accuracy of the test device was questioned by some prescribers indicating the limitations of the RDT kits:

> *Sometimes, they are not all that accurate. I can remember, last month, most of the patients we tested were negative. And when you crosscheck with microscopy, it proves positive. Sometimes if you don't even use the microscopy and then you treat the person clinically, the person gets well. Sometimes a person presents with fever, vomiting…and typhoid is negative. And sometimes malaria RDT is negative but you see that the person is having malaria. So when you treat the malaria alone, it's cured. So, I have the perception that the RDT though it's quick, sometimes, it gives us false results [P.A].*

Interviewed workers demonstrated their awareness of the limitations of the malaria RDT and some were quick to give their own assessment of the kit. Issues of concern were the kit's ability to detect only one species and ability to detect parasites at a certain threshold limit:

> *The limitation is that it can detect only falciparum. Also, at low parasite density, the kit may not detect the parasite. I have 80% confidence in the malaria RDT because of its limitation. We've been using the RDT with the BF. Sometimes, the RDT will show negative but the BF will show positive. So I don't have 100% confidence in the RDT [MLT].*

> *RDT is good. But then they have a limitation. The available RDTs don't test the other kinds of species of malaria. So when you do it and it's Plasmodium falciparum negative, you tend to think whether it could be other forms of malaria and so whether you should treat or not. That is the main challenge [MO].*

> *Our cases of malaria, about 90% of them are falciparum. And you know the financial issue. And they say that the type that detects all the species, the cost is so high that is why they give this one. If we can get the RDTs that capture all the species, better [PHO]*

The above analysis shows how participants perceived the usefulness of the RDT kits. Even as some strengths were identified, there were also some noted limitations.

Perception of the policy of testing before treating and adhering to malaria test results

The test before treat policy is to ensure that all suspected malaria cases are tested using either RDT or microscopy. The policy on adherence to test results also ensures that only positive cases receive antimalarial.

The respondents had a positive perception of parasite-based treatment of malaria. They believed that it was an intervention to curtail abuse of antimalarial, which could consequently, lead to resistance; missing of other diagnoses that could threaten the life of people; and ensure the judicious use of resources:

> *It's helpful. It's a good policy. So that you don't treat when it's not necessary. It also helps to think outside the box. Because not every febrile case may have malaria. So doing the RDT or malaria test is essential. And I'm also aware of the triple T policy: Test, treat and track. That's what's going to help us overcome the challenge, malaria, especially in situations like our setting where money is the problem, treatment must be well guided and it is some of these interventions that will help. Otherwise, you will overburden the patient or the National Health Insurance Scheme [MO]*

> *I think the policy of testing before treatment is a very brilliant one. Why would you want to give somebody treatment based on what you think is wrong with the person when you can know what is wrong with the person? That is the main thrust behind the policy. If you suspect, you test before you treat. It's like every other illness. Would you give somebody who has headache a typhoid medication because you suspect all headache come with typhoid without doing a widal test, even though some people say with the widal test, it doesn't always point towards you having the typhoid?[PHO]*

> *It's a nice policy because a person might experience symptoms which mimic malaria. It might not necessarily be malaria. So testing it first to see whether it is malaria before you administer the drug is very important. Because we don't want a situation where people will abuse the drug. Those parasites will one day become resistant to it [MLS]*

> *It's very good. To me, that's the way to go. Because, now, medicine has shifted from just clinical diagnosis to evidence based. So if there is any way you can confirm what you're treating, it's better. I think it reduces the stay of a patient in the hospital. It reduces a lot of cost. Because most of the cases probably we were thinking it is malaria, when you do the test it's negative. So you can imagine a doctor just giving people antimalarial without them needing it [MO].*

Although the perceptions of malaria RDT kit was fairly good, issues were raised such as perceived limitations of the kit. Respondents were of the view that the policies on parasite-based treatment are in the right direction.

4.2.5. Suitability of malaria RDT use

Although microscopy is the gold standard tool for the diagnosis of malaria, participants were of the view that use of the RDT kit was very important. The first reported reason for its suitability in the hospital was during odd hours:

> *You can't always rely on your microscopist to be around. So, as a first line, if somebody presents to a facility; if the microscopist is not around; sometimes you go to the hospital at dawn, the lab is not working and if you present with malaria symptoms, do we have to wait for the lab next morning? That time lag could be the difference between somebody dying and a lifesaving intervention so as a first line of treatment, if you presents with the symptoms of malaria at the casualty, an RDT can test for the presence of malaria within 10 to 15 minutes and drugs can be administered [PHO].*

Cutting down the patient waiting time during emergency situations or heavy patient turnout moments was also an important reason for the use of RDT although microscopy services might be available:

> *It doesn't take a long time. Microscopy takes a long time and so if someone has a very severe case and you need to get the results quickly before treatment, it's a quick method of diagnosing malaria. Even among non-severe cases, the advantage of speed in testing for a case is admirable to clients when RDT is used. We want the results. And so once the results are out, he or she gets the treatment and the person can leave. So, it's good. It's okay [OTSS member/MLS].*

> *It's necessary because, sometimes, the RDT actually help and save time. Because, sometimes, you send about 20 patients to the lab. Maybe because of lack of human resource, there is one person in the lab or 2 and about these 20 patients, if he's using the RDT, it goes faster than using the microscopy [P.A.].*

Reasons for using RDT and BF simultaneously

The suitability of using RDTs in hospitals where there were microscopy services was attributed to other benefits such as using the tool to complement or guide the microscopy process, hence, simultaneously using RDT and BF for diagnosing malaria:

> *When you're seeing RDT positive and you're seeing BF negative, you will be a bit careful. It will prompt you to check again or do another slide [MLT]*
>
> *In the light of the RDT being able to detect only P. falciparum, if you can afford, I don't think it's a bad thing. Because in the end, the aim is to be able to diagnose and treat. So if you have two methods that you could use…, and no method is fool proof. So, if you're using both and one doesn't detect it, you have a better chance of still getting your diagnosis right more than if you're using just one method [MO].*
>
> *Since the RDT detects the antigen, a person might be treated today. When they come a week later, still, the test will be positive. But when you do the slide, it will be negative. So if you always depend on the RDT kit, you'll always be writing positive positive for even those who have been treated. That is why I say, me for example, I do both RDT and BF [MLS].*

A prescriber had a contrasting view with regards to using both diagnostic tools:

> *So if they believe in the RDT, and it is good for us too, I don't think they should be wasting time to do the microscopy in addition. If they wish to do parasite count, then they should do microscopy than waste RDTs. So that situations where you can't do microscopy, then you do the RDT [P.A.]*

Although many respondents were of the view that using both RDT and BF helped to produce a more quality result, dissenting views saw that as a waste of resources and display of distrust for RDT.

Reasons why some negative results are treated

The prescribers gave reasons that they had low confidence in negative results sometimes and so they believed that treatment of such cases saved lives:

> *If I test and it's negative and the person has malaria, if you don't treat, the person will come back with severer case. So if I suspect, then it will be clinical malaria and then I will treat. It is better to save life than to stick to the policy and kill people [PA].*
>
> *Yes, there've been few cases that a patient will come with all the classical symptoms of malaria. You will do your further analysis and find out that even though RDT is negative,*

it still points to malaria and then when you treat the malaria, they get better. So, probably, I think because it's something that is manufactured, there may be some errors in the kit. There may be some problems with the temperature changes, storage of it. All those things can contribute to all those things happening. So I've had cases like that. That I still treated and they got better[MO]

When the parasite is in the liver stage and you don't treat although the test result is negative, and you don't treat the patient, the patient will go home and come back. So I think the policy should take into consideration the physician's clinical judgement. Although malaria symptoms mimic other diseases, the physician with experience will be able to tell that a case is malaria. Evidence based medicine is good but not 100%. I will give it 90%[P.A].

It was deduced from the interviews that although the policy said treatment should only be given to positive cases, prescribers believed that in some rare conditions when clinical symptoms were very clear and even blood film produced negative in addition to RDT, they would administer the antimalarial. And often patients got better.

4.2.6. Challenges with the use of the RDT kit

Besides the limitations in the RDT technology mentioned earlier, respondents reported challenges during the use of the RDT kit. Operator errors, transportation and storage problems, non-availability of quality control and manufacturer defects were mentioned as some of the challenges with the use of RDT kit:

Sometimes, you open the RDTs and they don't have buffer. Some of them have just dried out. What really comes to mind is the adherence to protocol. In some cases, you're supposed to wait for 15 or…20 or 10 to 20 minutes before reading the results but some people will tell you that experience will tell you if you see a case is positive, experience can tell you about 4 minutes on. But the recommendation is to wait for the stipulated time. You might never know, it might go back to a discolored band. I'm sure that the lab guys will tell you that nine out of ten cases, if a positive band starts to show in about 3 or 4 minutes, 15 minutes later, it will remain same [PHO].

Some of these test kits that come, they must have the quality control to ensure that the batch is okay. So that if it is positive, then we know that it is true positive. Often, the challenges are with the technique [MO].

Sometimes, due to manufacturing defects, there are some of the kits that you put even the required amount of blood, add the buffer and it still doesn't flow. At times too, you will see that there is something wrong with part of the cassette or the kit is already open and you cannot guarantee it's specificity and so, you can't go ahead to use. Then there are also instances whereby the workload and other issues, the scientist may forget to take the

right amount of the sample to be introduced into the cassette. Even the timing is also a factor that might result in false positive or false negative result. But with the backup of the bf slides, these challenges are overcome in our facility [MLS].

So if you use a different buffer, you might not get the right results. If you adhere to the technicalities, you are likely to get the results. For instance if you use the buffer of a kit which test for the HRP2 to test for the HRP2/pLDH kit, you may get wrong results. It is not like, all buffers are buffer. You have to read well the insert in the kit before using it [MLS].

One issue that was reported by users of the RDT kit to have hampered the use of the kit was the inclusion of only one buffer container for the whole RDT box:

The main challenge is probably the buffer. First, it was one cassette, one buffer. But now, I think that the whole box has one buffer. So if it gets missing or it gets lost, you cannot use the rest of the kits in the box [MLS/OTSS member].

Sometimes when doing the test, you will adhere to protocol yet, the kit will not run the test. The sample will not migrate on the panel for a band to show. Sometimes, by the time the kit gets to us, it is about a few weeks to expiry. A colleague reported to me about fake RDTs in the system, warning us all to be careful with the kit[MLT].

The issue of lack of a platform through which direct users of RDT kit could communicate problems encountered while using the kit to manufacturers was raised by one scientist:

What I know is that in our part of the world, we don't have any way to report to the manufacturer [MLS].

When the above reported challenges were tested on subsequent respondents, it was unanimously agreed that it would have been helpful. However, a prescriber feared that given the fact that the kits were been supplied by donors meant that it would be an expensive request to make:

That would have been wonderful. But then the issue is that, as far as I know, it's from donor support. So, you can't talk much. We can't even provide it. People are donating. So how do you complain? Beggars have no choice. That's the issue. But then, we should look at it. We should be able to say that what you're bringing us should serve the purpose. And then, that should inform them that it's not anything. Don't just bring anything [MO].

4.2.7. RDT stock out

A question was asked to ascertain how stock levels of the RDT kits were enhancing the use among health providers at the selected facilities. Respondents reported of how inadequate and inconsistent supply of RDT was a major setback to the implementation of parasite based treatment of malaria:

> *RDT availability is the major problem. Often, it's not available. Sometimes, we receive consignment and it takes a very long time for another consignment to arrive. And the prescribers are always aware when RDTs are not available. We will be doing blood film and that one takes a very long time, and so a doctor may say that if I make all the numerous suspected cases go to the lab, I will be closing at 2:00. That's why most of the suspected cases are not tested before treatment [MLS].*

> *For now, we've even run out of RDTs for over a month and it was just supplied just yesterday. So, for over a month, we were not having RDTs [MLS/OTSS Member].*

In addition to the non-availability of test kits, another interviewee raised an issue with the long queues at the facilities, leading to unfavourable patient turnaround time:

> *If the person comes and we do not have RDT or microscopy, what do we do? Because of the policy of testing every case before treatment, under such a condition, should we sit? We will lose more lives. So, yes, they have made the policy but they should make room for some situations to permit us to treat if we don't have these things. And then, the number of cases we see does not permit us. Just as I said, 2 hours of turnaround time in the lab, if I am to see 60 to 70 cases and I suspect (because of fever and headache) malaria, and they will waste 2 hours in the lab and by the time they come, it means that I would have closed and be gone, why send all of them to the lab? So at least, they should be flexible with some of the policies they make [P.A.]*

The problem of long waiting time of clients was explained by the interviewees, especially the Medical Laboratory Scientists to be caused by the heavy workload:

> *When the person is referred to the lab we have to go through a lot of processes [MLS]. Since they started the 3t policy, they have been giving us RDTS. It's not sufficient but sometimes when you give the RDTs to a facility, about 2, 3 days, they come and say the RDT is finished. So consistency of the supply of RDTs will help us. Yes. The sufficiency. To make sure that there is always RDT available. To make sure that they test every suspected case [PHO]*

However it was deduced from the interview data analysis that some facilities were part of the problem of insufficient supply of RDT since they failed to consistently submit information on tested cases to ensure accountability to the Regional Health Directorate:

> *Once we're given the RDTS, we have to make sure that we enter all the data on RDT usage because they are going to base on that information to give us our portion so if they have given us 10000 RDTs and we have distributed them and yet only 2000 is reported, the region might still think that you still have 8000 sitting idle or unused. So because of that if you request for 10000 next consignment, they won't give you. Meanwhile, all the 10000 RDTs might have been used. Entries and report is the challenge in Obuasi. They come for the RDTs but keying the report in the system is the problem. So that's our main challenge [PHO].*

The Obuasi Municipal Health Directorate public health officer was asked the steps his outfit had taken to address the problem and he said letters had been sent to prompt defaulters. He revealed that retention of biostatisticians in the private facilities was a major setback:

> *For the data entry, when we go on monitoring, we tell them. Letters have been sent to facilities but still you find some facilities not uploading the data on RDT usage. But one key problem is with the private facilities. They keep on changing biostatisticians. You will go there and the person who was there and got trained will no more be there and a different person who has no knowledge about the data entry will be there [PHO].*

Based on the limitations and challenges with the use of the RDTs and implementation of test, treat and track policy for malaria control, all respondents unanimously wished for improved test

kits that would detect all the known human species of plasmodium. They complained that no cost would surpass early detection of malaria and prevention of complications from untreated malaria:

> *Our pregnant women are made to do series of tests and that has made us been able to eradicate most of the six killer diseases from children. Then, why shouldn't we manufacture RDTs that can take care of these vulnerable people? Because when they have malaria, it's easier for them to lose their lives. So there is no cost that should be so much. If we can get RDT that can detect all the parasites [MLS].*

> *If somebody can get malaria and get severe anemia and can lead to renal failure and all those things, then, it would be best to be able to catch it and treat it much more than missing it and waiting to spend more on complications. Of course, the numbers of parasite, the frequency would also count. So we have to also consider the next predominant species. It's better to be able to catch it and treat it than missing it and then coming back to treat it where we would have to manage the complications. Then, if we would be able to differentiate between the species, it would be interesting. That for a particular kit, a test line is for falciparum and another for say ovale, it will be interesting. It will also help us in tracking whether the incidence of other species is increasing or not [MO].*

RDT stock out was reported to be a major hindrance to the policy of testing every suspected malaria case. To the prescriber, if the RDT was not available and so patient turn around time was unbearable, the only way out was to treat presumptively.

4.2.8. Knowledge of HRP2 deletion

HRP2 gene deletion may lead to false negative and so it was tested to find if interviewees had knowledge of the mutation. Only few of the respondents had heard of the mutation. They were all yet to delve into literature to find more information on HRP2 deletion. Among the few who had heard of the mutation, some of them indicated that the knowledge made them doubt RDT negative results the more:

> *So I was even questioning that if this is really true, then the RDTs that we are using if the main thing that is detected is to know the presence of the parasite's histidine-rich protein 2 and that organism has undergone mutation to remove that particular thing from the system, then what is the RDT detecting?[MLS]*

However, some interviewees indicated that they had faith in the combination of both RDT and BF when the results were doubtful:

> *Knowing that we do BF in addition to RDT calmed my nerves [MLS].*

4.2.9. Organizational factors influencing the use of malaria RDTs

Another objective of the study was to establish the influence of organizational factors on the use of the RDTs in the health facilities. It was recounted how previous treatment guidelines had outlived their usefulness because of antimalarial resistance and therefore, the need for parasite based diagnosis and treatment:

> *We've come a long way and we still have a long way to go with drug resistance. That policy is in line with maintaining the drugs that we have at the moment. We all know what happened with chloroquine. There was a lot of "abuses" in the system. Once you presented to the facility and the doctor thought that you had headache and some tummy ache and joint pains, bam! You had it as a first line of treatment. I think at the time, it was even a policy. As the first line of treatment. Malaria drugs was the first line of treatment [PHO].*
>
> *But if people will adhere to the results and treat accordingly, I think it will be a very good thing. Microorganisms gaining resistance is a big issue. Just some years ago, chloroquine was fully effective but now, it's next to useless. If we don't protect the few drugs we have now, including especially antibiotics, we may be doomed [MO]*
>
> *We started with chloroquine and all this resistance came in. We came to Artemether. We went back to Quinine and now, we are coming back to Artesunate [P.A.].*

It was generally agreed that based on past experiences, before a prescriber could treat a case that had tested negative, other conditions, which could mimic malaria should have been ruled out (if resources are available). Therefore, if only RDT was done, microscopy should have been used to confirm:

> *Over here, what we do is, you have to test before we give antimalarial. If the patient test positive, then we give. But then also, we allow for the discretion of the prescriber also into play. But when you have tested for both microscopy and RDT which are negative, then, you don't treat malaria [MO*].
> *The thing is we don't just send a person to the laboratory for just malaria test. You add FBC, widal… (Though the test should not be relied on always) to actually rule out other infections. Sometimes, even typhoid can bring the same signs and symptoms as malaria. If the WBC is high, especially with children, it can present with fever. So if you send the person to the lab and you look out for other parameters and they are negative and still the person is presenting with fever and all those things, I think you should treat it. And if microscopy is also available, it is the best way to use it after RDT tests negative and the case still points to malaria. But even with the microscopy, sometimes the test will tell you it is negative meanwhile, the person is having the disease [PA]*.

Although respondents were of the view that the policy was good, some respondents had mixed feelings given certain circumstances of running out of kits or non-availability of microscopy:

> *I agree and disagree for reasons. It's good that you test every person coming with fever or symptoms that suggest that it is malaria. Because sometimes, you may think it's malaria meanwhile it will be a different thing that is giving the fever or maybe vomiting. But the other aspect I don't agree is: First, sometimes you can run out of RDTs. The microscope can break down. So if you say that all the patient coming with suspected malaria have to get tested before treatment, you mean that you can't achieve your goal. Because someone will come and it's actually malaria. But because you don't have the test kit or the RDT or the microscopy, shouldn't you treat? So, I think that with the RDT, we can also use the clinical judgement or the presentation of the patient to treat malaria. But if all the kits and microscopy are also available, then every suspected case must be tested before treating [P.A]*.

4.3 Chapter summary

This chapter has presented the results as obtained from analysis of the quantitative data obtained from the review of patients' folders and the qualitative data obtained from the semi-structured interviews conducted with the health providers in the Obuasi Municipality. The chapter has shown in the quantitative analysis that the percentage of RDT usage was 43%. It was reported that overall appropriate treatment rate for all diagnostic tools used for malaria diagnosis was 93.9% whereas RDT compliance rate was 89.9%. However, the difference in appropriate

treatment rates were not statistically significant. It was reported from the qualitative data analysis that RDT stock out was a major setback to the implementation of the test before treat policy. The next chapter presents the discussion of the results and how they relate to literature.

CHAPTER FIVE

DISCUSSION OF FINDINGS

5.0. Introduction

This chapter provides the discussions based on the results obtained in chapter four. The results are related to current literature in the field to show how they agree or disagree. There are six sections. Section one presents the proportion of RDT usage for testing malaria in patients at the facilities. Section two presents the prescriber use of RDT results. Section three presents the health system factors influencing the use of malaria RDTs. Section five presents the organizational factors influencing the use of malaria RDTs. Section six presents the chapter summary.

5.1. Proportion of RDT usage among patients tested for malaria

Rapid testing involves dispensing of specified quantity of blood to the sample well of a cassette and adding a buffer to enable migration on the panel of the kit (WHO, 2015a). Here, if plasmodium antigen is present in the patient blood, a positive band will show in addition to the control band. The study found that whereas rapid testing took about 15 minutes to read, microscopy took about 1 to 2 hours in the health facilities in the Obuasi Municipality. It is suggested that microscopy takes about 60 to 120 minutes (MS, 2015). In the Obuasi Municipality, it was found that microscopy was likely to take hours due to usual reported challenges of high patient turnout and limited human resources.

Under an ideal situation, microscopy should be used in a hospital. Notwithstanding, the Ghana Health Service advocates for malaria RDT use (GHS, 2015). Revelations from this study indicated that supply of RDT to hospitals was done through the National Malaria Control

Programme (NMCP) with funding from the Global Fund. The findings further revealed that due to workload, breakdown of equipment and the occurrence of emergency situations that may require rapid testing, the use of malaria RDTs in hospitals had come to stay in Obuasi.

It was found from the review of patients' folders/records in the health facilities assessed in the Obuasi Municipality in this study that 89 patients were tested for malaria using RDT only, 118 were tested using microscopy and 158 were tested using both RDT and BF. Since the focus of the study was to ascertain the proportion of RDT usage for testing malaria among patients, those patients who were tested using both tools were not taken into consideration in the calculation. Hence, the study found that the proportion of RDT usage among the selected facilities was 43% despite the common complaint of erratic supply of malaria RDT kits. The World Health Organisation (WHO) has reported the surge in demand globally for malaria RDTs (WHO, 2018). Although the search for literature on proportion of RDT usage in health facilities did not produce any distinct results, it could be said that if steady supply of malaria RDT was available to facilities, more patients would be tested for malaria using the RDT. The introduction of kits that could detect all species of malaria would further go down to increase RDT usage and reduce often seen laborious microscopy.

One major reason for the use of RDT in hospitals in the Obuasi Municipality was to cut down on patient turnaround time. Respondents reported using both RDT and BF simultaneously to complement each tool so as to increase their chances of detecting malaria parasites. This finding is similar to a Zambian study, which found that 94.6% had been tested with both RDT and BF (Manyando, Njunju, Chileshe, Siziya, & Shiff, 2014).

5.2. Prescribers' use of malaria RDT test results (in diagnosis)

The study found that the overall appropriate use of test results rate was 94%. Thus, of the 365 selected patients' folders, only 22 (6%) were prescribed with antimalarial although they tested negative. The category of patients who were tested using RDT and BF simultaneously were included when comparing usage among the different tools and made to stand as a category. This decision was made based on health workers' report that they used both tools to enhance their confidence in the test results.

Although it was found that there was no significant difference (statistically) between the treatment compliance and the type of diagnostic tool used (using Chi Square test of association), it was found that prescribers complied with negative test results the most when both RDT and BF were used (95.6%) followed by compliance rate of 94.9% of those tested using only BF. The treatment compliance rate for RDT only was 89.9%. The treatment compliance rate of 89.9% among those tested using RDT only was more desirable compared with other studies, which found treatment compliance rate of RDT tested malaria cases in selected health facilities in the Agona East District of the Central Region of Ghana to be 79.3% (Ansah-Koi, 2016).

In an observational study conducted in Zambia, 68.6% of tested children with negative results was administered with antimalarial (Manyando *et al*., 2014). In a similar study, Ansah-Koi (2016) recruited lower health facilities, which relied on RDT alone and so, microscopy was not available. Additionally, the study was conducted in a setting where other laboratory services such as testing for full blood count and urine examination were not available to check whether sepsis or urinary tract infections among other ailments with similar signs and symptoms were the cause of ailment. The aforementioned deficiency may account for the higher rate of non-compliance among the selected health facilities encountered in the Ansah-Koi's (2016) study. In

another study, the focus was on children (Manyando *et al*, 2014). This could account for the high rate of giving of antimalarial so as to prevent infant deaths attributable to malaria.

5.3. Health system factors influencing the use of malaria RDTs

It was revealed through the interviews and observation that the RDT test kits currently been used for malaria detect HRP2 and pLDH, an improvement on HRP2-only detecting RDTs, which is susceptible to HRP2 gene deletion. Gene deletion has been reported several years ago (Gamboa, 2010). However, it was revealed through the interviews that the supply of RDT kits detecting only HRP2 antigen by the Ghana Health Services to health facilities in Obuasi continued till 2018.

Notwithstanding, the expected improvement in detection of malaria cases due to addition of the pLDH marker in the kit cannot be over emphasized. The addition of pLDH to the *Plasmodium falciparum* detecting kit will help detect parasites that may have deleted their HRP2 genes. In addition, the issue with false positive as a result of persisting HRP2 even after recovery from the infection will be curtailed as pLDH is produced by live parasites (GHS, 2015).

The study found that with regards to training, almost all the health workers interviewed apart from one prescriber had had some form of formal training in the use of malaria RDT. Furthermore, the onsite training and supportive supervision team (OTSS) for malaria control from the Obuasi Municipal Health Directorate's periodic visit to the various facilities provided supervision and training on diagnosis and treatment for the frontline workers in the municipality. In a systematic review of malaria RDT use in Sub-Saharan Africa, it was found that malaria RDT use was fairly good when users had received training in its use (Boyce & Meara, 2017). In

the context of the facilities included in the study, RDT was executed by laboratory professionals who had had formal training in the use of malaria RDT.

The study's finding of reported operator errors such as not waiting for specified time before reading results and addition of the right buffer and in the right quantity was similar to Uzochukwu *et al.'s* (2013), experience where Nigerian health workers using RDT, among other errors, did not add the right amount of blood nor wait for the specified time before reading results. The onsite training and supportive supervision team (OTSS) is one practice when done effectively could help ameliorate the aforementioned problem.

The study observed that provider perception of RDT effectiveness was fairly good. Despite the limitations of the kit such as the inability to detect the lesser known species of plasmodium and low parasite density, it was perceived that, RDTs were the future for malaria diagnosis - they are suitable, good, helpful and satisfactory. The reported perception that at some parasite density, the kit might not detect the parasite is confirmed by Mcmorrow and fellows (Mcmorrow, Aidoo, & Kachur, 2011). They found that the HRP2 RDT kit could only detect effectively, parasite loads from 200/µL. Yet, parasite load beneath this acceptable threshold was shown to have produced some symptoms of malaria (Miller & Sikes, 2015).

The study observed some implementation challenges as well. For instance, other malaria RDT implementation challenges reported include stock out, inadequate quality assurance, poor quality assurance, defect in the kits, non-availability of frontline worker platform for reporting faults to manufacturers and human resource deficits. In a qualitative study conducted in a similar Ghanaian setting, the aforementioned challenges were reiterated in addition to poor involvement

of frontline workers in policy formulation, which could hamper malaria RDT use (Boadu *et al*., 2016).

Although the proportion of suspected malaria cases diagnosed pathologically in private health facilities have been seen to be very low globally (WHO, 2014) the two private facilities included in the study (AGA Health Foundation and St. Jude Hospital) recorded about half of the total number of suspected cases tested among the five selected facilities with the AGAHF alone testing about 41% of the total number. The above mentioned facilities are but only two of the twelve health facilities in the Obuasi Municipality. The complaints from the OMHD that the private health facilities are often not uploading data for statistical reasons is similar to the afore-mentioned complaints of the WHO about the poor performance of private facilities with the test before treat policy.

5.4. Organizational factors influencing the use of malaria RDTs

The qualitative findings revealed that respondents had knowledge of current and previous treatment guidelines (which permitted presumptive treatment and the giving of antimalarial such as chloroquine). It was deduced from the interviews that as *P*. *falciparum* malaria has gotten resistant to chloroquine, the first-hand use of the drug is no longer effective. The introduction of artemisinin combination therapies (ACTs) in the late 1990s and the implementation of ACTs as first-line treatment by most African countries by the early 2000s 'have changed the cost-benefit ratio of empirical treatment of fever' (Murray, Gasser, Magill, & Miller, 2008).

To preserve the efficacy of ACTs, prescribers were of the view that although there might be challenges, all patients should be tested before treatment (if possible) and treatment should be

based on test results except under rare conditions where other diseases that produce similar signs and symptoms have been ruled out, given the history of the country with regards to malaria. In a qualitative study in a Ghanaian district, health workers believed that not treating individuals with fever was risky given the endemic nature of malaria in Ghana (Boadu *et al*., 2016).

5.6. Chapter summary

This chapter has presented evidence that both RDT and microscopy (BF) were used simultaneously to complement each tool. The key findings have been related to extant literature as well. Prescribers understand that they must comply with test results to guard against antimalarial resistance but are also aware of the limitations of the tools used to diagnose malaria. And so, under special conditions when other diseases that mimic the symptoms of malaria have been ruled out, they still treat patients who test negative to RDT. The next chapter presents the summary, conclusions and recommendation of the study.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.0. Introduction

This chapter presents the summary, conclusions, recommendations, contributions, limitations to the study and future research. Summary of the study summarises the study objectives, methods and findings. Contribution to policy and practice, methodology and theory are also presented in the contribution to knowledge subsection. Limitation(s) and future research subsections are also presented in this chapter. The conclusion remarks are captured by the conclusion section.

6.1. Summary of the study

A mixed method approach involving quantitative and qualitative research methods were applied to determine factors influencing the use of RDT in malaria diagnosis in the Obuasi Municipality. Proportion of RDT usage in the diagnosis of malaria in the health facilities in the Obuasi Municipality was found to be 43% despite reported erratic RDT supply and limitations of the kit. The rate of using RDT test results to appropriately diagnose and prescribe was also desirable (89.9%).

6.2. Conclusions of the study

The conclusions of the study in relation to the specific objectives have been presented in this section.

Even though there were reported shortage of RDTs, 43% of tested malaria cases utilized RDTs. This shows that if supply of RDTs is steady, more people will be tested using it and presumptive diagnosis will be completely eliminated. Overall, 158 (43%) patients were tested using both

RDT and BF. Although it was not initially part of the study's specific objective, chi square test of association was used to see if there was any statistically significant difference between the use of both tools simultaneously to diagnose malaria and appropriate giving of antimalarial to patients. No association was thus found. Despite the knowledge of health workers of the limitations of the RDT kit, they had a fairly positive perceptions regarding malaria RDT use.

If the challenges mentioned by the interviewed participants are given due attention, the use of RDTs in the testing and treatment of malaria would be optimized.

6.3. Contribution to knowledge

The study's contribution to knowledge in relation to policy and practice, methodology (the use of quantitative and qualitative method of analysis) and theory has been presented below.

6.3.1. Contribution to policy and practice

Ghana signed a pact with the World Health Organization's *Roll Back Malaria Initiative* (GHS, 2017). Hence, the health policy that all suspected malaria cases are promptly treated using parasite based diagnosis and appropriate antimalarial at all levels of healthcare is key to controlling malaria. The findings of the study show the proportion of patients tested for malaria using RDT, the challenges faced by healthcare providers when using the kit, and their perceptions of malaria RDT kits. Healthcare managers and policy makers could use the findings of the study to make meaningful decisions with regards to the quality of RDTs to be procured, in-service training programmes to be organised for their staff and investment in local manufacturing of malaria RDTs.

6.3.2. Contribution to methodology

Some quantitative findings such as the use of both RDT and BF simultaneously and the giving of antimalarial to malaria negative patients were triangulated using in-depth interviews. Also, the deficiency in the quantitative aspect of the study such as inability to use all secondary data was augmented by rich qualitative methods adopting in-depth interviews and observation. Thus, this study encourages the use of mixed method approaches to health system and policy research.

6.4. Recommendations

Based on the study findings, the following recommendations are made:

6.3.3. Contribution to theory

The theory of reasoned action (Schiavo, 2007; University of Colorado, 2019) was used to frame the scope of the research. The organizational factors such as policies regarding the use of parasite-based diagnosis fits the description of the subjective norms of the provider whereas their perceptions fit their attitude. Future research on malaria RDTs could focus on how patient factors form part of the prescriber's subjective norms. The elements identified in this study could be extended to the theory of reasoned action.

The Ministry of Health / Ghana Health Service in collaboration with academia, local entrepreneurs, foreign investors, the World Health Organisation and other stakeholders should focus on making available, locally produced malaria RDTs of the highest quality that can test all species known to cause diseases in Ghana.

The steady supply of diagnostic logistics for malaria should be made available to health facilities.

More national service personnel with statistics and science background should be regularly trained and posted to health facilities that may lack biostatisticians.

All health facilities should ensure that RDT and BF results are recorded clearly and separately in record books or on an electronic platform.

6.5. Limitations to the study

The main limitation to the study was that because it was student funded, only the required minimum of study participants and patient folders (sample size) were drawn for the study. Better findings might be gotten from a study that would enrol all the patients tested for malaria within the study period and in all the 19 health facilities in the Obuasi Municipality. Suspicion from possible biases resulting from small samples of people tested using only RDT from the selected minimum required sample of people tested for malaria could have been curtailed if all qualified subjects were involved in the study. Again, in some facilities involved in the study, results on patients tested using both RDT and BF did not distinguish between RDT and BF results.

6.6. Future research

Census of all malaria tests done in all health facilities in a year and recording practices of health workers in the Obuasi Municipality are some suggested areas of research. It is suggested that future studies should increase the sample size and adding more health facilities in the Obuasi Municipality or Ashanti Region in future studies. This will help to ensure comparison between institutions of similar characteristics and vice versa.

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APPENDICES

Appendix One: Information Sheet

UNIVERSITY OF GHANA, LEGON

SCHOOL OF PUBLIC HEALTH

DEPARTMENT OF HEALTH POLICY, PLANNING AND MANAGEMENT

Topic: Assessment of Factors Influencing the use of Malaria Rapid Diagnostic Testing in Health Facilities in Obuasi, Ashanti Region of Ghana

INFORMATION SHEET

I am Richard Opoku, a Master of Public Health Student of the University of Ghana, Legon.

I am doing a research on "Assessment of factors influencing the use of malaria rapid diagnostic test in health facilities in Obuasi, Ashanti Region of Ghana".

I will like to get your view on this area. This session will be digitally recorded and kept for a period of two years after which all information will be deleted.

If you need any clarification or further information please let me know. This interview should not take more than an hour and half of your time.

Appendix Two: Consent Form

CONSENT FORM

Researcher: Richard Opoku (0208076044)

Research Supervisor: Dr. Reuben Esena (0277220276)

Ghana Health Service Ethical Review Administrator: Hannah Frimpong (0507041223)

Please Initial Box

Interview will be audio recorded and transcribed at the same time ☐

I confirm that I have read and understood the information sheet above and I have had the opportunity to ask questions ☐

I understand that my participation is voluntary and I am free to withdraw at any time ☐

I agree to take part in the above study ☐

I agree to the use of anonymized quotes in the publication ☐

…… …… ……..

Name of Participant Date Signature

…… …… ……

Name of Researcher Date Signature

Appendix Three: Interview Guide Form

UNIVERSITY OF GHANA, LEGON

SCHOOL OF PUBLIC HEALTH

DEPARTMENT HEALTH POLICY, PLANNING AND MANAGEMENT

INTERVIEW GUIDE FOR HEALTH WORKERS

Assessment of Factors Influencing the use of Malaria Rapid Diagnostic Test in Health Facilities in Obuasi, Ghana

1. Sex:

2. Highest Level of Education:

3. Current Position:

4. Number of years of work experience:

5. Have you ever received training on RDT?

6. If yes, when was that?

7. How long was the training?

8. Job specification:

9. Which type of kit is usually used for diagnosing malaria?

10. What is the source of your RDT for malaria diagnosis?

Perception

11. Is the rapid diagnostic kit easy to use?

12. Do you have confidence in RDT results?

13. As a personnel in a health facility with microscopy, do you think the malaria RDT is necessary in your facility?

14. What is your view about the policy of testing before treatment of malaria?

ADHERENCE

15. Have there been situations where you have prescribed antimalarial to patients who tested negative to RDT? If yes can you talk about it?

16. Do patients sometimes ask you to prescribe antimalarial even though the results of RDT are negative?

17. Are you willing to test a person for malaria and provide anti-malarial based on the results.

18. What are some of the challenges preventing you from testing before treatment?

19. What do you usually do if the results are negative but the person shows clear symptoms? of malaria?

Implementation Challenges

20. What are some of the challenges faced when using the rapid diagnostic test?

21. What steps must your facility take to have RDT kits and how difficult or easy are these steps?

22. Have you experienced any RDT supply issues like shortages within the past six months?

Knowledge about *Pf*HRP2/*Pf*HRP3 Deletions

23. Have you heard/read about the problem of *Pf*HRP2/*Pf*HRP3 deletions?

24. If yes, which regions in the world are experiencing this phenomenon?

25. Has there been reported cases of gene deletions in Ghana?

26. How do your answers to questions 23 and 24 influence your decision making when a febrile case tests negative?