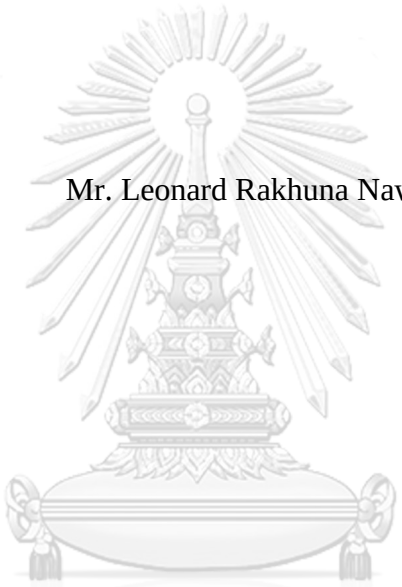
Factors Influencing Practice Regarding Severe Malaria Among Health Workers in Central Province, Papua New Guinea.

Mr. Leonard Rakhuna Nawara



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ปัจจัยที่ส่งผลต่อการดูแลรักษาโรคมาลาเรียชนิดรุนแรงของบุคลากรด้านสุขภาพในเขตจังหวัดเซ็นทรัล ประเทศปาปัวนิวกินี

นายเลียวหนาด รากุนนา นาวารา

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรมหาบัณฑิต
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Thesis Title	Factors Influencing Practice Regarding Severe Malaria Among Health Workers in Central Province, Papua New Guinea.
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เลียวหนาด รากุนนา นาวารา : ปัจจัยที่ส่งผลต่อการดูแลรักษาโรคมาลาเรียชนิดรุนแรงของบุคลากรด้านสุขภาพในเขตจังหวัดเซ็นทรัล ประเทศปาปัวนิวกินี (Factors Influencing Practice Regarding Severe Malaria Among Health Workers in Central Province, Papua New Guinea.) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: นพ. อเลซซิโอ พันซ่า, 164 หน้า.

มาลาเรียที่มีอาการรุนแรงนั้นนำไปสู่ความเจ็บป่วยและการเสียชีวิตหากไม่ได้รับการรักษา ปาปัวนิวกินีเป็นประเทศหนึ่งที่มีการระบาดของโรคมาลาเรียสูงที่อยู่นอกกลุ่มประเทศในแอฟริกาใต้เขตตอนใต้ทะเลทรายซาฮารา การศึกษานี้มีวัตถุประสงค์เพื่อหาปัจจัยที่ส่งเสริมการปฏิบัติงานในการดูแลรักษาผู้ป่วยด้วยโรคมาลาเรียที่มีอาการรุนแรงของเจ้าหน้าที่สาธารณสุขในจังหวัดเซ็นทรัล ประเทศปาปัวนิวกินี

การศึกษาเป็นแบบภาคตัดขวางโดยทำการเก็บข้อมูลในสถานบริการสุขภาพในช่วงเดือนพฤษภาคม พ.ศ. 2561 มีผู้ให้ข้อมูลจำนวน 420 คนในการตอบแบบสอบถามด้วยตนเอง ข้อคำถามซึ่งเป็นตัวแปรสำหรับการวิเคราะห์นั้นครอบคลุมในทุกด้านของการจัดการดูแลผู้ป่วย ได้แก่ การปฏิบัติโดยรวม การวินิจฉัย การรักษา และการติดตามผู้ป่วย ซึ่งผลที่ได้จากตัวแปรมีได้เพียง 2 ค่า ใช้การวิเคราะห์ความถดถอยโลจิสติคในการพยากรณ์ตัวแปรที่มีความสัมพันธ์กับการปฏิบัติงานในการดูแลรักษาผู้ป่วยด้วยโรคมาลาเรียที่มีอาการรุนแรง

ผลพบว่าเจ้าหน้าที่ขาดการเข้าฝึกอบรมและไม่ได้รับการนิเทศ เจ้าหน้าที่ร้อยละ 90 มีความรู้ในระดับต่ำถึงปานกลาง ความรู้ในระดับสูง ทัศนคติที่ดีในการตอบสนองและมีสิ่งชักนำให้เกิดการปฏิบัติที่น่าพอใจ มีความสัมพันธ์กับการติดตามผู้ป่วยหลังการจำหน่ายจากการรักษาอาการมาลาเรียรุนแรงของเจ้าหน้าที่ การรับรู้ถึงประโยชน์ของการรักษาในระดับสูงมีความสัมพันธ์กับการปฏิบัติตามขั้นตอนการดูแลรักษาผู้ป่วยโรคมาลาเรียที่มีอาการรุนแรงโดยรวมและการปฏิบัติตามขั้นตอนของการรักษา

ผลการศึกษาพบว่าระดับการรับรู้ถึงประโยชน์ของการรักษาสูง ระดับความรู้สูง ทัศนคติที่ดีในการตอบสนอง และการมีสิ่งชักนำให้เกิดการปฏิบัติที่น่าพอใจมีความสัมพันธ์กับการปฏิบัติงานในการดูแลรักษาผู้ป่วยด้วยโรคมาลาเรียที่มีอาการรุนแรงในแต่ละด้านแตกต่างกัน

สาขาวิชา สาธารณสุขศาสตร์ ลายมือชื่อนิสิต .....

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KEYWORDS: INFLUENCING FACTORS, PAPUA NEW GUINEA, PRACTICE, SEVERE MALARIA

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Severe malaria is the severe form of malaria which usually leads to significant morbidity, or death if left untreated. Papua New Guinea (PNG) is one country outside sub-African where malaria is heavily endemic, despite the recent positive progresses resulting from intensified control. This study was designed to describe the current practice and investigate factors influencing practice regarding severe malaria among health workers in Central Province, PNG.

This was a health facility-based cross-sectional study conducted in May 2018. A total of 142 participants completed self-administered questionnaires for analysis. The dependent variable covered all aspects of case management: overall practice, diagnosis, treatment and follow up in dichotomous outcomes – compliant and non-compliant. Pearson chi-square and Fishers exact test were used to identify associations between independent and dependent variables, and logistic regression was used to control confounders and identify predictors associated with practice regarding severe malaria.

Training was lacking, where only 18.3% received some form of training in the last 6 months. Low-moderate knowledge was prevalent in 90% of the participants. Negative attitude to clinical practice was associated with non-compliance in overall practice. High knowledge, positive attitude to responsiveness and favourable cues were associated with following up of discharged severe malaria patients. High perceived benefit was associated with compliance in overall and treatment practices.

This study found that high perceived benefits, high knowledge, positive attitude to responsiveness and favourable cues were associated with different aspects of practice regarding severe malaria.

Field of Study: Public Health Student's Signature .....

Academic Year: 2017 Advisor's Signature .....

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List of acronyms

ACT	Artemisinin-based Combination Therapy
AL	Artemether-lumefantrine
CHW	Community Health Worker
CP	Central Province
DDT	Dichloro-diphenyl-trichloroethane
DHA PPQ	Dihydroartemisinin piperaquine
DHS	Demographic and Health Survey
EBP	Evidence-Based Practice
HBM	Health Belief Model
HEO	Health Extension Officer
IMAI	Integrated Management of Adult and Adolescent Illnesses
IMCI	Integrated Management of Childhood Illnesses
IOC	Item-objective congruence
LLIN	Long-lasting insecticide treated nets
MD	Medical Doctor
MIS	Malaria Indicator Survey
NHIS	National Health Information System
NO	Nursing Officer
NSO	National Statistics Office
PCA	Principal Component Analysis
PHA	Provincial Health Advisor
PNG	Papua New Guinea
RDT	Rapid Diagnostic Test
SAVVY	Sample Vital Registration with Verbal Autopsy
SD	Standard Deviation
WHO	World Health Organisation

CHAPTER 1

INTRODUCTION

1.1 Background and Rationale

1.1.1 Malaria

Malaria is a disease caused by parasites of the genus *Plasmodia*, and it affects red blood cells in the human body. There are four main plasmodia species that cause human disease, they are *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale* and *Plasmodium malariae* [1]. There is the fifth plasmodia species, *Plasmodium knowlesi*, that usually resides in monkeys but can jump onto human beings and cause disease [1]. *Plasmodium falciparum* is the most common cause of severe disease (severe malaria) [2], but *Plasmodium vivax* [3] and *Plasmodium knowlesi* can also cause severe malaria [4, 5]. The malaria parasite is transmitted from one person to another by the bit of a female mosquito of the genus *Anopheles* that are identified as malaria vectors. Severe malaria, as the name suggests, is a severe form of malaria that affects multiple organs in the body and clinically manifests accordingly [6].

1.1.2 Global Malaria Situation

Despite the combined efforts for eradication of malaria, the disease continues to remain a global public health problem. As off 2016, malaria was endemic in 91 countries of the world [7]. Successive world malaria reports to date show that the Africa Region is where the burden of malaria is heaviest. In 2015, Africa contributed up to about 90% of the total malaria mortality reported in the world [7].

Over the last 15 years the world has seen decline in malaria trends in most endemic countries. The global number of malaria cases fell from 262 million in the year 2000 to 214 million in 2015, a drop by 18% [8]. The incidence declined by 37% globally between 2000 and 2015 [8], and in Africa the number of cases declined by 42% [8]. Fifty-seven of the endemic countries reduced malaria incidence by >75% [8]. Malaria

deaths globally fell from 839000 to 438000 between 2000 and 2015, a reduction by 48% [8]. The declines followed shortly after huge investments were made in malaria, especially in low and middle-income countries [9]. The investments have been manifested in two forms: rolling out of artemisinin-based combination therapies (ACTs) and making long-lasting mosquito nets (LLINs) widely available as much as possible [9].

However, after all these unprecedented periods of successful malaria control, progress has stalled, according to the latest world malaria report. In 2016, there were an estimated 216 million cases of malaria in the 91 endemic countries [7], an increase of about 5 million cases over 2015. There was slight reduction in total investment made in malaria between 2015 (2.9 billion USD) and 2016 (2.6 billion) [7].

1.1.3 Malaria Situation in Papua New Guinea (PNG)

PNG as a tropical country is no exception in terms of malaria endemicity. Ninety-four percent of the country's landmass is malaria endemic [10], and this is where 90% of the country's total population resides [10, 11]. About 56% live at altitudes below 1,200 metres where malaria transmission is stable, 12% live at altitudes between 1,200 and 1,600 metres where malaria transmission is unstable (epidemic prone) and a further 23% live at altitudes between 1,600 and 2,000 metres where just vivax malaria is endemic. The remaining 9% live in areas above 2,000 metres where no significant malaria transmission occurs [10]. Cumulatively, 94% of PNG's landmass is malaria endemic [10].

There are four human malaria parasites found in PNG, and they are (in order of prevalence); *Plasmodium falciparum* (82.9%), *Plasmodium vivax* (15.1%), *Plasmodium malariae* (2.1%) and *Plasmodium ovale* ([12]. Studies have shown that both *Plasmodium falciparum* and *Plasmodium vivax* can cause severe malaria [13, 14]. Like other highly endemic areas, serious physical impacts have been observed to be most prevalent in the vulnerable population, such as children under five and pregnant women [15, 16].

In previous years till late 1990s, the burden of malaria has been so heavy. It was ranked the third common cause of morbidity and mortality with rates of 219.49/1000 and 8.54/1000 respectively [17]. It was also the most frequent cause of outpatient visits, having an annual incidence of 303 cases per 1000 people at risk [17]. Recently PNG had made a lot of progress in the fight against malaria manifested by progressive declining trends, which coincided with the malaria world. A Malaria Indicator Survey (MIS) in 2014 showed an incidence of 48 cases per 1000 people [18]. In 2015, a total of 301,829 malaria cases were reported in an estimated at-risk population of 6.5 million people [19], which gave an incidence of 46 cases per 1000 people.

However, the figures between 2015 and 2016 collated via the National Health Information System (NHIS) showed significant increase [20], which coincides with global report 2017 [7]. The total number of reported malaria cases in 2016 was 563,574 [20], which yields an incidence of 88 cases per 1000 people.

Several species of *Anopheles* mosquitoes transmit malaria parasites in PNG. Nevertheless, the main vector is *Anopheles farauti,* which belongs to the *Anopheles punctulatus* group. In low-lying areas, this mosquito breeds in riverbanks, marshes, lagoons and estuaries throughout the year, allowing malaria transmission all year round. All malaria vectors in PNG feed both indoor and outdoor, and rest mostly outdoors [21].

1.1.4 Epidemiology of Severe Malaria

In many parts of the world where malaria is endemic, gathering specific data on the prevalence or incidence of severe malaria is not so easy [22] due to various reasons. A supplement published by Tropical Medicine and International Health in 2014 identified several factors that makes accurate description of severe malaria incidence problematic: (i) Malaria is most prevalent in low socioeconomic societies where identification, documentation and reporting are weakest [23]; (ii) a significant proportion of severe malaria and deaths occur at home [23]; (iii) In those severe malaria cases recorded in health facilities, the probability of missed diagnosis or over-

diagnosis is present [24, 25]. Nevertheless, the WHO-sanctioned supplement estimated the global annual incidence of severe malaria to be around 2 million [23].
The situation is similar in PNG where specific data for severe malaria has much to be desired. However, on the understanding that malaria-related admissions and mortality are usually due to severe malaria [26-29], some clue can be extracted from PNG's NHIS which collates morbidity and mortality information on malaria from all public health facilities around the country. On the stated understanding, the assumed number of severe malaria cases in 2016 would be, the total number of inpatients (10,189) and deaths (282) is 10,271 [20]. This figure was an increase compared to 2015 (9093) [19]. As calculated by NHIS, the case fatality rate in 2016 was 0.014%. Several reasons are possible for such a (lower) fatality rate. Firstly, it can be the result of actual result of reduction in malaria incidence at least over the last decade, up until 2016. Secondly, it may not be true representation of the actual picture. A study in Zambia in 2011 using a WHO-standard methodology for Sample Vital Registration with Verbal Autopsy (SAVVY) showed fewer than half (49%) of patients who suffer severe malaria reach health facilities, and assumed that up to 90% of severe malaria deaths occur at home and 20% occur at health facilities [30]. Further still, under reporting cannot be excluded. All these may imply that the actual morbidity and mortality due to severe malaria in PNG could be higher.

1.1.5 Problem Statement

Severe malaria is a life threatening emergency that needs prompt diagnosis and effective treatment, as death can occur within hours [31]. Mortality from untreated or inappropriately treated severe malaria (particularly cerebral malaria) approaches 100% [6]. Prompt diagnosis and institution of effective treatment in severe malaria is paramount. In view of all the facts highlighted above, and the fatality of the condition and complexity in treatment, health workers' practice regarding severe malaria is vital. This research will describe current practice and assess factors associated with practice regarding severe malaria among health workers in the Central Province (CP) of Papua New Guinea based on modified 'health belief model.'

1.1.6 Rationale

The rationales for this study are as follows;

1. Continuous exposure to malaria infection enables an individual to develop (acquired) immunity against the disease [32-35]. The progressive declines in malaria trends in PNG observed over the last 15 years means that fewer people had been infected with malaria. A study based on mathematical modelling showed that such populations lose immunity in the first 5 – 10 years [36]. The reason behind the sudden upward trend since 2015 is a concern when the same control activities have been employed with sustained intensity. History shows that PNG was at the verge of eradicating malaria in early 1980's during the dichloro-diphenyl-trichloroethane (DDT) and chloroquine era [37]. However, when there was resurgence in late 1980s and into 1990s, mortality rose to levels comparable to sub-Saharan African countries [17]. At the current state, it is logical to do a 'proactive' background search on the status of health workers practice regarding severe malaria now to identify knowledge gaps, barriers, attitudes, etc., and plan ahead rather than being reactive as always.
2. After searching PubMed, google scholar and Cochrane with the key words "malaria AND papua new guinea," three articles have been identified regarding malaria case management practice among health workers in PNG, at least after the revised treatment protocol was rolled out in 2011. However, there are gaps with these studies. Data for the first descriptive cross-sectional study published in 2012 [38] was collected before introduction of the revised (current) treatment policy, thus, the findings from that study are not very relevant today. The second descriptive cross-sectional study was done in 2013 in the context of uncomplicated malaria, and it did not investigate associations between variables [39]. The most recent study published in 2016 was also a descriptive cross sectional in the context of uncomplicated malaria, without any association analysis [40]. There is a separate unpublished health facilities survey report available [41], but this is also mostly descriptive in the context of uncomplicated malaria only. None of these studies have described practice regarding severe malaria or evaluated associations with health workers' practice regarding severe malaria. This study will not only describe practice

regarding severe malaria, but also look at relationships between different variables.

3. This will be a pioneer study concerning health workers practice regarding severe malaria. Although the study will have limitations as any research study has, it will provide useful information to policy makers and valuable hint for future researchers on the subject.

1.2 Research Questions

i. What are the modifying factors (socio-demographic characteristics, socio-economic characteristics, professional characteristics, knowledge level) of health workers in reference to practice regarding severe malaria in CP, PNG?

ii. What are the attitudes (attitude towards clinical practice, attitude towards responsiveness) and perceptions (perceived susceptibility, perceived severity, perceived barriers, perceived benefits, self-efficacy) towards practice regarding severe malaria among health workers in CP, PNG?

iii. What are the cues to practice regarding severe malaria among health workers in CP, PNG?

iv. What is the practice regarding severe malaria among health workers in CP, PNG?

v. Is there any relationship between modifying factors, individual attitudes and perceptions, cues and practice regarding severe malaria among health workers in CP, PNG?

1.3 Research Objectives

1.3.1 General Objective

To describe individual characteristics and practice regarding severe malaria among health workers, and to assess any association between these characteristics and practice regarding severe malaria among health workers in CP, PNG.

1.3.2 Specific Objective(s)

i. To determine modifying factors among health workers in reference to practice regarding severe malaria in CP, PNG?

ii. To determine individual attitudes and perceptions towards practice regarding severe malaria among primary health care workers in CP, PNG?

iii. To determine the cues to practice regarding severe malaria among primary health care workers in CP, PNG?

iv. To determine the current practice regarding severe malaria among health workers in CP, PNG?

v. To assess any relationship between modifying factors, individual attitudes and perceptions, cues and practice regarding severe malaria among health workers in CP, PNG?

1.4 Research Hypotheses

1.4.1 Null Hypothesis

There is no association between modifying factors, individual attitudes and perceptions, and cues to practice regarding severe malaria among health workers in CP, PNG.

1.4.2 Alternate Hypothesis

There is association between modifying factors, individual attitudes and perceptions, and cues to action with practice regarding severe malaria among health workers in CP, PNG.

1.5 Conceptual Framework

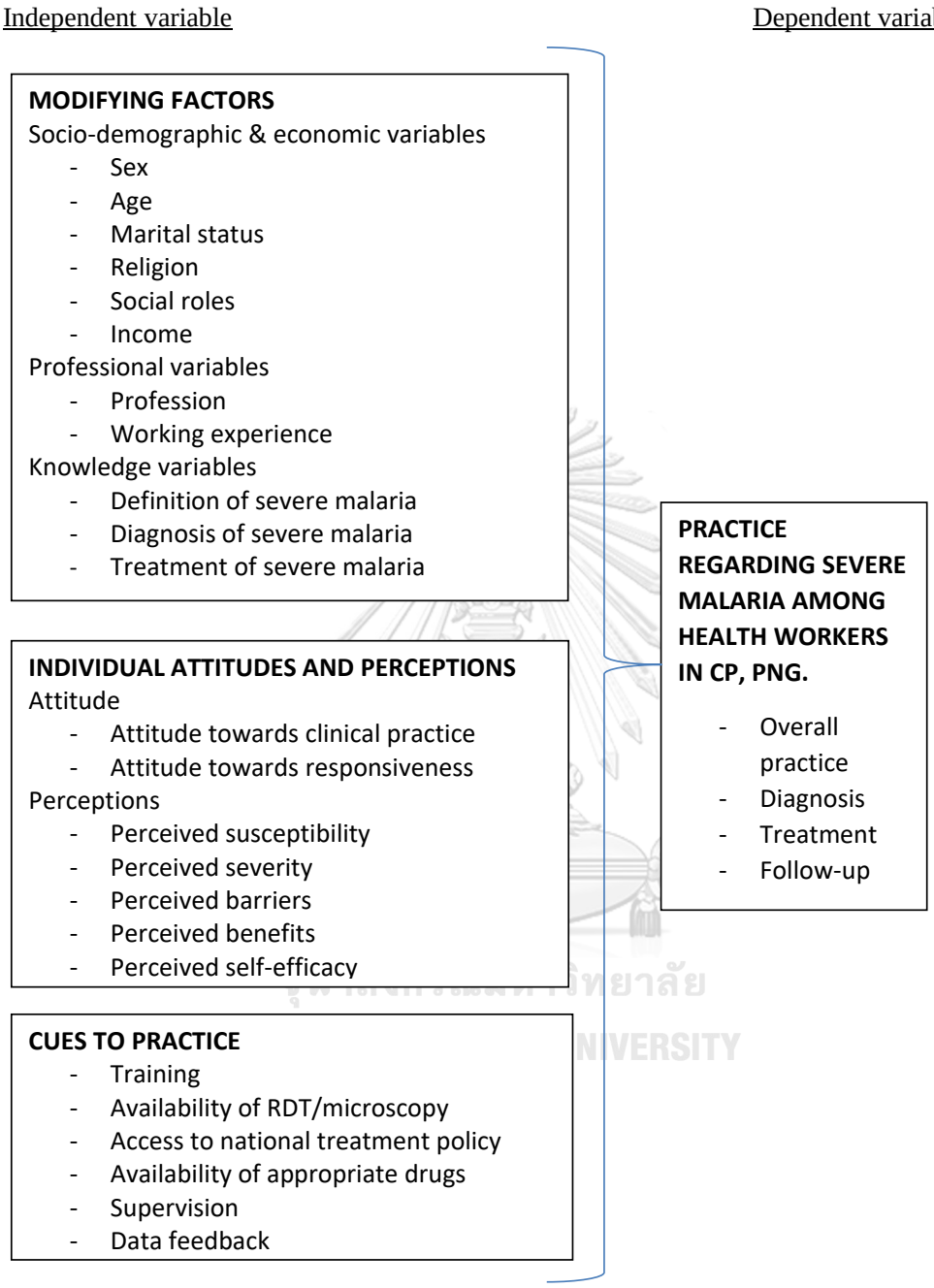


Figure 1: Conceptual Framework based on Health Belief Model

1.6 Operational definitions

1.6.1 MODIFYING FACTORS

Refers to socio-demographic and economic, professional and knowledge variables.

1.6.1.1 Socio-demographic and Economic Variables

Sex: Refers to sex characteristics of the respondent. This will be observed by the interviewer. Gender will be put into male or female.

Age: Refers to the birthday anniversary of the respondent on the last date of birth. It will be self-reported and divided into below 40 years and more than or equal to 40 years.

Marital status: Refers to wheather the participant is currently living with a spouse or not. This will be self-reported and will be grouped into married, never married, widowed or divorced.

Religion: Refers to whatever religion the respondent belongs to, wheather he actively practices his faith or not.

Social roles: Refers to any extra-curricular social positions the respondent may hold working as a full-time health worker at a health facility. This includes executive to community groups, church leadership, industrial union and political affiliations. This will be self-reported and answers will be yes and no.

Income: Refers to salaries received by the participants on fortnightly basis from the government. In PNG health workers serving in public facilities are paid by the government on fortnightly basis.

1.6.1.2 Professional Variables

Profession: Refers to the cadre of health worker of the respondents. This information will be obtained from the office of the officer-in-charge (OIC). The cadre of health workers will be put into four groups according to the cadres of health

workers in PNG. They are: 1. Community Health Worker (CHW); 2. Nursing Officer (NO); 3. Health Extension Officer (HEO); and 4. Medical Doctor (MD).

HEO is a profession unique to PNG, which was introduced in the 1980s to relieve shortage of doctors in rural health facilities. They are trained above nurses and below doctors. They provide general medical care, including minor surgeries, and public health management at rural facilities.

CHWs are not uniform across the world, depending on the health system. In PNG, CHWs are professionally trained – lower than nursing officers – health workers whose curriculums are designed in such a way to work in primary health care facilities. However, there are CHW positions available in tertiary facilities as well where some actually
work there as nursing aids.

Work experience: Refers to the number of years or months the participant has been engaged in doing clinical work in malaria hyperendemic areas (coastal and lowland provinces). This will be self-reported. Work experience years will be put into three groups; less than 10 years, between 10 and 20 years and more than to 20 years. Less than 10 years will reflect those new health workers into the system. Between 10 and 20 years will reflect those workers who started work soon before or after PNG started seeing declines in malaria trends. More than 20 years will reflect health workers who worked on the older treatment policy as well as during high malaria burden era.

1.6.1.2 Knowledge Variables

Definition of severe malaria: Refers to parasitologically confirmed malaria case with the presence of one or more of certain clinical features called danger signs. Danger signs in children are unable to drink or breastfeed, vomiting, convulsions, lethargic or impaired conscious, neck stiffness, chest indrawing or stridor [42]. Danger signs in adults are being very weak or unable to stand, lethargic or impaired consciousness, neck stiffness, convulsions, respiratory distress or severe abdominal pain [43]. Questions will be posed to assess the ability of health workers to define severe

malaria. This variable will be measured together with other variables of the same and categorised into low, moderate and high.

Diagnosis of severe malaria: Refers to combination of clinical features combined with a positive parasitological test (via rapid diagnostic test (RDT) or microscopy) to diagnose malaria. Questions will be posed to respondents to assess their knowledge on this variable. This variable will be measured together with other variables of the same and categorised into low, moderate and high.

Treatment of severe malaria: Refers to treatment of severe malaria refers to treating severe malaria according to the PNG national treatment guidelines, i.e., using parenteral artesunate or artemether has the first-line treatment for severe malaria. Once patients can swallow, a full course of artemether lumefantrine be given. Questions will be posed to respondents to assess their knowledge on treatment of severe malaria. This variable will be measured together with other variables of the same and categorised into low, moderate and high.

1.6.2 INDIVIDUAL ATTITUDES AND PERCEPTIONS

Attitude refers to subjective judgements by the respondents, and it will be measured in two parts; attitude towards the patient and attitude towards responsiveness. Perceptions refers to views formed by the health workers regarding different aspects of severe malaria, and it will be measured in five parts; Perceived Susceptibility, Perceived Severity, Perceived Barriers, Perceived Benefits and Perceived self-efficacy.

1.6.2.1 Attitude

Attitude towards clinical practice: Refers to subjective judgement (not based on scientific evidence) of respondents towards patients, especially severe malaria patients. Both negative and positive statements will be provided to measure attitude, and will be categorised measured as discouraging, neutral and supportive.

Attitude towards responsiveness: Refers to respondents' subjective judgement towards responsiveness. Responsiveness has two components: (a) respect for persons (dignity, confidentiality and autonomy); and (b) client orientation (prompt attention, basic amenities and choice of provider). To measure responsiveness, positive and

negative statements will be provided and responses will eventually be grouped as discouraging, neutral and supportive.

1.6.2.2 Perceptions

Perceived Susceptibility: Refers to respondents' beliefs about the likelihood of a patient being affected by severe malaria. Negative and positive statements are provided to measure perceived susceptibility and will be grouped into high and low.

Perceived Severity: Refers to respondents' belief on how serious the effects of severe malaria are on one's health status. Negative and positive statements were provided to measure perceived severity and were grouped into high and low.

Perceived Barriers: Refers to factors respondents' belief as impediments to undertaking recommended practice in terms of practice regarding severe malaria. Negative statements were provided to measure perceived barriers and were grouped into high and low.

Perceived Benefits: Refers to incentives (monetary or non-monetary) the respondents may expect for providing care to severe malaria patients. Monetary incentives include wage/salary increase and bonuses. Non-monetary incentives include promotion, recognition from supervisors, and respect from the community. Negative and positive statements were provided to measure perceived susceptibility and were grouped into high and low.

Perceived self-efficacy: Refers to respondents' confidence to practice regarding severe malaria. Positive statements were provided to measure perceived susceptibility and were grouped into high and low.

1.6.3 CUES TO PRACTICE.

Refers to strategies to activate readiness. This is comprised of Training, Availability of RDT / Microscopy, Accessibility to National Malaria Treatment Policy, Availability of Appropriate Drugs, Supervision, and Data feedback. All variables under cues were all scored together grouped into 'favourable' and 'unfavourable.'

Training: Refers to any form of training (both internal and external) responders have attended that has covered practice regarding severe malaria. Trainings include any form of training regarding severe malaria, integrated management of childhood illnesses (IMCI), or on the national malaria treatment policy.

Availability of RDT / Microscopy: Refers to wheather or not there is constant supply of a malaria diagnostic modalities (RDT or microscopy) at a health facility.

Accessibility to National Malaria Treatment Policy: Refers to wheather there are national treatment policy materials accessible to the respondent. The materials include the national treatment booklet, treatment policy charts on the wall of the health facility, or any other related material.

Availability of Appropriate Drugs: Refers to the continuity in availability of PNG's first-line antimalarial drugs for severe malaria (artesunate or artemether injection) at a health centre.

Supervision: Refers to wheather or not the respondent was supervised at least once in the last 6 months by a senior health worker from within the health facility or someone from the provincial or national level in terms of practice regarding severe malaria. In PNG, four officers from National Malaria Control Program are assigned to each of the four regions of the country to visit every facility are at least twice a year.

Feedback & data sharing: Refers to sharing of malaria data on morbidity, mortality and practice at a health facility in the past 6 months. As mentioned above, In PNG, four officers from National Malaria Control Program are assigned to each of the four regions of the country to visit every facility are at least twice a year.

1.6.4 PRACTICE REGARDING SEVERE MALARIA

In this study, practice regarding severe malaria refers to diagnosis, treatment and follow-up of severe malaria cases, according to PNG national guidelines. The outcomes were divided into two groups: 1. Compliant; and 2. Non-compliant.

Diagnosis: Refers to diagnosis of severe malaria by a combination of clinical features and positive parasitological test. Questions were posed to enquire about how respondents diagnose severe malaria. Responses were grouped as 'good' and 'poor'.

Treatment: Refers to treatment of severe malaria according to the PNG national treatment guidelines, i.e., using parenteral artesunate or artemether followed by a full

course of artemether lumefantrine (AL) once patients can swallow, has the first-line treatment. Responses were grouped as ‘good’ and ‘poor’.

Follow-up: Refers to advising a patient who has been treated for severe malaria and discharged to return to a health facility for follow-up to see if the patient remains asymptomatic at home. Responses were grouped as ‘good’ and ‘poor’.

CHAPTER 2

LITERATURE REVIEW

2.1 MALARIA

2.1.1 Aetiology and Symptoms

Malaria is a disease caused by parasites of the genus *Plasmodium* when inoculated into human body by feeding female mosquito of *Anopheline* species. The disease starts by infecting red blood cells, and later affects multiple organs if left untreated. There are five species of plasmodia that can cause human malaria; *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium ovale*, *Plasmodium malariae* and *Plasmodium knowlesi*. *Plasmodium knowlesi* is transported from monkeys to human, thus it is called monkey malaria parasite. The other four species are transported from human to human (human malaria parasite). Malaria cases due to *Plasmodium knowlesi* are being reported from South-East Asia, especially from Borneo [6]. Malaria starts with nonspecific symptoms which include fever, lassitude, fatigue, headache, joint and muscle aches, headache, lassitude, fatigue, abdominal discomfort and muscle and joint aches, chills, reduced appetite, perspiration, malaise and vomiting. Children may also present with lethargy and diarrhoea. In the early stages (uncomplicated malaria), a rapid and full recovery is expected with prompt and effect treatment. However, in left untreated or ineffectively treated, severe disease can ensure, commonly with *Plasmodium falciparum* but *Plasmodium vivax* and *Plasmodium knowlesi* can also cause severe disease. Progression to severe malaria may take a few hours to days. Severe malaria usually manifests with one or more of the following features: hypoglycaemia, coma, metabolic acidosis, acute kidney injury pulmonary oedema (respiratory distress) [6].

2.1.2 Severe Malaria

When an individual has been inoculated with a plasmodium parasite, a variety of clinical effects may follow, within the sequence:

Infection → Asymptomatic parasitaemia → Uncomplicated illness → Severe malaria → Death

Several factors determine the disease manifestation of the infection and the progression to the last two categories. These factors include the species of the infecting parasite, level of innate and acquired immunity of an individual, and timing and efficacy of the treatment instituted, if any [23].

For epidemiological purposes, the World Health Organisation (WHO) strictly defines severe malaria basing on a mixture of clinical features, laboratory and other features.

Table 1: Manifestations of Severe Falciparum Malaria in Adults and Children [2, 6, 23]:

Prognostic value			**Frequency**	
Children	**Adults**	**CLINICAL MANIFESTATIONS**	**Children**	**Adults**
+++	+++	Impaired consciousness	+++	++
+++	+++	Respiratory distress (acidotic breathing)	+++	++
+	++	Multiple convulsions (>2 episodes within 24h)	+++	+
+	+	Prostration	+++	+++
+++	+++	Shock	+	+
+++	+++	Pulmonary oedema (radiological)	+/ -*	+
+++	++	Abnormal bleeding	+/ -*	+
++	+	Jaundice & disfunction of other vital organs	+	+++
LABORATORY INDICES				
+	+	Severe anaemia	+++	+
+++	+++	Hypoglycaemia	+++	++
+++	+++	Acidosis	+++	++
+++	+++	Hyperlactaemia	+++	++
++	++	Renal impairment (acute kidney injury)	+	+++
+/ -	++	Hyperparasitaemia	++	+

*Infrequent

The underlying mechanism through which severe malaria causes multiple organ disease is a combination of ; 1. Reactive endothelium (blood vessel wall), 2. Aggregation of disfigured red blood cells, and 3. Further platelet mediated aggregation [44, 45].

Severe malaria is treatable, however, if left untreated or inappropriately treated the mortality reaches 100% [6]. WHO's Malaria Treatment Guideline 2015 recommends artesunate as the preferred first-line treatment for severe malaria after overwhelming evidence [6, 31, 46, 47].

2.1.3 Who is at Risk of Severe Malaria?

In endemic areas, the risk for severe falciparum malaria is highest in young children, visitors from nonendemic areas, pregnant women in second and third trimester, patients with HIV/AIDS and post-splenectomy people [2]. Severe *Vivax* malaria is also highest among young children and people with comorbid conditions, while being rare in returned travellers to temperate regions [2]. In areas of lower endemicity, severe malaria occurs in both adults and children. Non-immune travellers and migrants are vulnerable to severe malaria, irrespective of the endemicity of the area where they acquire infection [23].

2.1.4 Endemicity and Immunity

The clinical state of the disease depends largely on the level of immunity of an individual. This immunity is the result of intensity of malaria parasite in an area. Where populations are continuously exposed to malaria parasite (entomological inoculation rate >10/year). They develop partial immunity to clinical progression of the disease in early childhood, and so the risk of developing severe malaria is reduced. Adolescents and adults of high malaria transmission areas are semi-immune and seldom manifest clinical illness while continuing to have low parasite densities. The acquired immunity can wane through some stages of life, especially during pregnancy, when individuals move to non-endemic areas for many years or when individuals develop chronic immune-suppressive diseases. In areas of unstable malaria transmission, the intensity of malaria transmission fluctuates widely by season and year and over relatively small distances. *Plasmodium vivax* is an important

cause of malaria in these regions. The entomological inoculation rate is usually < 5/year and often < 1/year, although there are usually small foci of higher transmission in areas in which asymptomatic parasitaemia is common. The generally low transmission retards acquisition of immunity, so that people of all ages suffer from acute clinical malaria, with a significant risk for progression to severe malaria if it is untreated or ineffectively treated. Epidemics may occur in areas of unstable malaria transmission when the inoculation rate increases rapidly because of a sudden increase in vectorial capacity. In epidemics, severe malaria is common if prompt, effective treatment is not widely available. With effective malaria control, such as population-wide coverage with effective vector control and wide-scale deployment of ACTs, the number of inoculations is usually greatly reduced. This will be followed in time by a corresponding change in the clinical epidemiology of malaria in the area and an increasing risk for an epidemic if control measures are not sustained [6].

The coastal and islands areas of PNG are generally hyperendemic, with areas of holo-endemicity. People in these areas develop immunity that protects them from serious illness and death. Very young children, pregnant women, and immigrants, have no immunity, suffer the most consequences due to severe malaria. In contrast, people in the highlands infrequently experience malaria, and do not get the opportunity to develop immunity. When they contract malaria, the disease takes a virulent course, which may result in death [21].

2.2 OVERVIEW OF PNG NATIONAL MALARIA TREATMENT POLICY

In line with updated WHO guidelines, PNG revised her malaria treatment policy in 2010. All suspected malaria cases must first be parasitologically confirmed via microscopy or RDT, except for children under 5, [6, 21] before any treatment is instituted. The first-line and second-line treatment of uncomplicated malaria in PNG are artemether-lumefantrine (AL) and dihydroartemisinin piperaquine (DHA PPQ) respectively [21], according to weight category. In line with extensive studies and recommendation, artesunate injection is the preferred first-line treatment for severe malaria [6, 21, 47]. However, donated artemether (injection) is widely availability so

both artemether and artesunate injections are accepted as first-line treatments of severe malaria. Quinine injection is the second-line treatment for severe malaria.
As soon as patients can swallow, it is recommended that they take a full course of oral recommended antimalarial treatment (as per uncomplicated malaria treatment guideline) to make up a combination therapy [21].

AL is not recommended for the treatment of uncomplicated malaria during first trimester of pregnancy, instead, oral quinine and sulfadoxine pyrimethamine (SP) are recommended in combination. For severe malaria in pregnancy, parenteral artesunate, artemether and quinine are all recommended. When patients (pregnant women) can swallow after parenteral treatment, oral SP plus quinine and AL are recommended for the first trimester and subsequent trimesters respectively. SP for malaria prophylaxis is further recommended for pregnant women only.

Table 2: Summary of PNG Malaria Treatment Protocol

			Conditions	First line treatment	Second line treatment
Uncomplicated		1	Uncomplicated falciparum malaria and suspected malaria	AL tablets	DP tablets
		2	Malariae malaria		
		3	Uncomplicated vivax malaria	AL plus PQ tablets	DP plus PQ tablets
		4	Ovale malaria		
		5	Mixed infection of Pf/Pv/Po/Pm	Same as treatment of uncomplicated falciparum malaria, treat with PQ for 14 days if *Pv* infection	
Severe		6	Severe malaria (both falciparum and vivax)	Artesunate injection, followed by AL when patients can swallow	QN injection , followed by QN and doxycycline tabs when patients can swallow
Pregnancy	Uncomplicated	7	1st trimester of pregnancy	QN tablets plus SP tablets	
		8	2nd and 3rd trimesters of pregnancy	AL tablets	QN tablets plus SP tablets
	Severe	9	1st trimester of pregnancy	artesunate injection QN injection	
			2nd and 3rd trimesters of pregnancy	Artesunate, QN or artemether injection	

Abbreviations:
AL – artemether lumefantrine
DP – dihydroartemisinin piperaquine
QN – quinine
SP – sulphadoxine pyrimethamine
Pf – *Plasmodium falciparum*
Pv – *Plasmodium vivax*
Po – *Plasmodium ovale*
Pm – *Plasmodium malariae*

2.3 MALARIA STRATIFICATION IN PNG.

PNG is located close to the equator so temperatures do not show much seasonal variation but depend mainly on altitude. In most parts of the lowlands (<1,200 meters) there is perennial transmission, with only limited seasonality. As altitude increases, transmission decreases significantly becoming unstable at an altitude of 1,200–1,700 metres. Above 1,700 metres temperatures generally tend to be too low for local malaria transmission. An estimated 94% of PNG's 7.17 million population live in areas that are classified as highly endemic for malaria [48]. About 56% live at

altitudes below 1,200 metres where malaria transmission is stable, 12% live at altitudes between 1,200 and 1,600 metres where malaria transmission is unstable (epidemic prone) and a further 23% live at altitudes between 1,600 and 2,000 metres where just vivax malaria is endemic. The remaining 9% live in areas above 2,000 metres where no significant malaria transmission occurs. However, the situation is complicated by the fact that many people with houses at relatively high altitudes have gardens at lower altitudes where they sometimes (seasonally) sleep to protect their crops. Substantial heterogeneities in malaria epidemiology are found not only along broad environmental gradients, but also between

villages only a few kilometres apart and even between different clusters of houses within the same villages. Local heterogeneity in the spectrum of vectors present and, in their densities, is also important. In the highlands, one village can have endemic malaria, while a neighbouring village is malaria free, and epidemics tend to be localized rather than affecting large areas [10, 21, 48].

2.4 HEALTH SYSTEM IN PAPUA NEW GUINEA

Health services in PNG are primarily the responsibility of the State, delivered through a decentralized public management system. The non-state sector through church health services also play a critical role in the delivery of health care, managing and providing a large proportion of the rural health services across the country. The Government provides 79% of total health expenditure and subsidizes the church health services to such an extent that they are considered part of the public system. The system is financed predominately through tax revenue and donor funds, and at the health facility level user fees are charged to supplement sometimes lack of operating funds. [10, 37].

PNG has low numbers of health professionals per head of population. In 2009 a World Bank report cited that there was a total of 13,063 personnel who worked across the PNG health system. This workforce was made up of: medical officers 379 (3.0%), HEOs 416 (3.2%), nurses/midwives 3,252 (28.0%), CHWs 4,398 (34.0%), laboratory staff 258 (2.0%), dental officers 123 (1.0%), allied health workers (physiotherapy staffs, pharmacy staffs, radiology staffs, etc) 318 (2.4%), and administrative and other support staff 3,394 (26.0%). This equates to only one doctor per 17,512 people; one

nurse per 2,041 population, and one CHW per 1,500 population [10, 49]. Apart from medical officers, the qualification and job description of each three lower health worker cadre in PNG are as follows:

Health Extension Officers (HEOs) - The HEO program started back in 1960s as a diploma program by Australian colonisers. The main purpose was to bridge the gap between doctors and the population. Over the years the program has evolved. In 2002 was it amalgamated to Divine Word University (DWU) and offered as a bachelor program with years of schooling and two of internship. Their educational preparation is almost similar to that of physicians where problem-based learning is enmeshed into the medical didactics and theoretical background. Students take courses for four years, including biological sciences, principles of internal medicine and public health. Theoretical courses and clinical rotations running simultaneously add to the overall rigor of the program. After internship they are registered with the Medical Board of Papua New Guinea, then become legitimate health workers. The HEO curriculum is designed for these professional to serve in rural facilities. Often dubbed as the "rural doctors," HEOs deliver comprehensive care and health education, especially in the provinces and deeper parts of the country. Since scope of practice is almost similar to that of physicians, HEOs are also able to perform physical examinations, order treatments, and interpret laboratory and diagnostic results [50].

Nursing officers – Professional nursing in PNG augments the services rendered by professional medicine and aims to provide health care services in both urban and rural settings. Working alongside physicians, nurses are at the forefront of delivering holistic care in primary and specialty patient care areas. Nursing officers in PNG are trained over threes and graduate with a diploma in general nursing. During their first year of employment, they are assisted by their employers to get registered with the Nursing Council of Papua New Guinea. Nursing officers easily find employment across all levels of health facilities. At high facilities, they basically carry out doctors' orders, covering all ranges of patient. At lower facilities, they perform all range of duties, i.e, if they are alone. If they are with HEOs, usually bigger or more technical tasks such as pleural tap are reserved for HEOs. Career pathway for nursing officers

permit them to become specialist nurses, including midwives, after a further 1-year program at a recognised institution within the country. At the moment there are four universities within PNG who provide the 1-year bachelor's program for nurses. After bachelor's degree, those who wish to continue on to masters or PhD can do so overseas, mostly Australia [51].

Community Health Workers (CHWs) – The origin of CHWs in PNG dates back to early 1940s when the profession was first introduced as aid post orderlies (APOs) by then Australian colonisers. These orderlies were to receive a 3 – 4 months training and live within the community and provide basic medical care. Gradually over the years the profession was evolving. During the 1978 Alma-Ata conference on primary health care, CHWs gained global recognition and support as playing a key role in the strategy to achieve the 1975 'Health for All by the year 2000'. Many programs for CHWs were established in the 1970s in low and middle-income countries to implement these goals set by the WHO. In line with the WHO recommendations, the National Department of Health in PNG has further developed a CHW program in which health workers are trained to deliver primary health care to rural majority. Since 2001 CHW training programs were overall to competency-based to bridge essential knowledge and skills gaps that were lacking in previous programs. The curriculum provides an organisational structure that promotes the concept that the CHW is an essential member of the health team and: (i) is one of the most effective persons to provide PHC to the rural areas; (ii) is involved with promoting community action and participation in the health care of individuals, families and the community as a whole; and (iii) ensures that the high quality of the service is based on the knowledge and skills acquired during training and the subsequent supervision and support that is provided. CHWs trained in PNG must complete a 2-year certificate program with access to clinical sites for their practical placements as well as acquire further practical skills after completing the theory. Furthermore, CHW students are required to demonstrate their skills in simulations and are observed by trainers from the institution before being exposed to real settings. This ensures that CHWs are ready for the many tasks they will encounter immediately upon graduation. Graduating CHWs are employed by different organisations (including church, government, non-

government organisations and the private sector) after being trained and registered with the Nursing Council of PNG. They receive support, mentorship and salary through the different organisations that employ them. Most CHWs are employed by government and the church health services. As CHWS are registered and recognised with a license to practice, they have career paths in any area within the health sector if they meet the selection criteria. CHWs in PNG can do basic medical care, public health (including rural patrols) and administration when they are alone. Where they work along with other staffs, such as HEOs or nursing officers, they may be assigned to perform specific functions [52].

In 2008, the number of (and percentage) of health workforce by cadre and workplace are shown in Table 3.

Table 3: Number (and %) of health workforce in PNG by cadre and workplace, 2008

	Hospitals	Health centres, Subcentres, Aid posts	Total (%)
Medical officers	326 (83.2)	66 (16.8)	392 (3.0)
HEOs	87 (19.2)	365 (80.8)	452 (3.5)
Nurses, midwives	1,622 (42.9)	2,155 (57.1)	3,777 (29.3)
CHWs	1,093 (24.6)	3,356 (75.4)	4,449 (34.5)

Data from National Health Plan 2011 – 2020 [50].

In 2013, there were 22 provincial hospitals, 734 registered health centres and 1,672 Aid Posts that serve the majority of the provincial population [10]. Health services in PNG are organised at five levels: central, provincial, district, sub-district, and village levels.

National Referral Hospital. The Port Moresby General Hospital in the Central Province is the national referral hospital in the country. It provides specialist medical services in all medical specialties and sub-specialist services for some specialties. It serves a larger population due to influx and referrals from all over the country.

Provincial hospitals. There is one provincial hospital in each province. There is also one specialist psychiatric hospital run by the government. Four provincial hospitals

double as regional hospitals. Currently all hospitals are funded by the government. Core clinical services and subspecialty clinical services are provided by respective medical specialists and specialist nurses on-site. In principle, a wide range of clinical support programs as well as public health programs are available in these tertiary hospitals.

District & rural hospitals. Provide full basic health services including medical, surgical, obstetric, paediatric, trauma and 24-hour emergency care for both inpatients and outpatients. District hospitals cover a population of 40,000 to 300,000 depending on availability and accessibility of other health facilities nearby. District and Rural hospitals are staffed by at least two HEOs, then nursing officers and CHWs. Few may have a medical officer.

Health centres & Urban clinics. Rural health centres and sub enters provide services including management of chronic and acute conditions, basic surgical care, deliveries, and paediatric care, and function as intermediary referral points between district lower level facilities and district hospitals. The government more commonly runs the larger health centres, Health centres serve a population of 5,000 to 20,000. Urban health clinics provide similar services as health centres. Health centres typically have at least one health extension officer, several nursing officers and community health workers. Urban clinics receive referrals from Aid Posts and health sub-centres.

Health sub enters. Rural. Deliver the same services as health centres (above). Church groups more commonly run the smaller sub enters. Health sub-centres are staffed with one nurse and a few community health workers (CHW).

Aid posts. Rural aid posts comprise more than 70 percent of all health facilities and deliver basic health care including mother and child care, and community-based health promotion. Staffed by CHW(s) with two years training, aid posts serve a defined population of between 500 and 2,000 often in remote locations. A significant number have closed due to shortages in funding, staff, and other resources. Where there are no aid posts, village health volunteers, village birth attendants and Marasin

Meri (medicine women) provide basic first aid and health education in villages and homes.

The health services system in PNG applies a primary health care concept, with health centres being the main operational units for the system. The health centres are backed up by a referral system consisting of: first-level hospitals (district hospitals); second-level hospitals (provincial hospitals); and the national referral hospital (Port Moresby General Hospital). Almost all provinces been under direct control of the national government. However, after the Provincial Health Authority Act 2007, respective provincial health authorities are starting to take over entire health affairs of each province. In 2015, there were 22 provincial hospitals, 734 registered health centres and 1,672 Aid Posts that serve the majority of the provincial population [10].

With the exception of two rurally located hospitals, church-run health services serve 80% of the rural population and make up the bulk of rural health services in PNG, managing around 46% of facilities and 52% of service delivery [10]. Church-run health services are often located in more remote areas. The private health sector is very small in PNG, principally consisting of mining sector facilities, private doctors, and traditional healers. There are approximately 80–100 private practitioners in PNG, with most located in Port Moresby and Lae, the first and second headquarters of PNG. Traditional healers provide close to 5% of healthcare in rural areas, and less in urban areas [10].

2.5 RELATED STUDIES AND LITERATURE

2.5.1 INTRODUCTION

Case management of severe malaria does not get much attention in many parts of the world where malaria is endemic. A cross sectional study in Uganda by Achan et al. 2011 showed that emphasis on management of severe malaria was often neglected and practice was sub-optimal [53]. The same is true for PNG; studies on practice regarding severe malaria among health workers has much to be desired. Studies done so far in PNG on malaria case management practices among health workers have all been centred around uncomplicated malaria [39, 40, 54]. Much of the literatures reviewed below are taken from studies on practice regarding uncomplicated malaria.

2.5.2 MODIFYING FACTORS

2.5.2.1 Socio-demographic and Economic Factors

Sex and Age

Some studies have described the association between sex and practice regarding malaria case management. A quantitative analysis in Tanzania in 2008 showed that female clinicians were more likely to adhere to guidelines than their male colleagues [55]. This finding agreed with a cross-sectional study from Morocco in 2006 [56] which also showed that female health workers were likely to comply than their male counterparts.

The association of age with practice regarding malaria has differed in different studies; while some studies have found association, others have not. A cross-sectional study in Kenya in 2015 found that primary health care workers over 40 years were likely to perform better than their counterparts who were less than 40 years ($p < 0.001$) [57]. However, other studies have found no association between age and case management among primary health care workers [58].

Marital Status and Social Roles

A study in northern Uganda which took into account marital status to assess association with performance of health workers regarding malaria, pneumonia and typhoid found no statistically significantly association between marital status and health worker performance [59]. The same study noted that getting involved in many outside activities negatively impacted health workers' performance regarding malaria, pneumonia and diarrhoea [59]. PNG is a society where formally employed people automatically have some degree of status in their respective communities. As such, the chances of them holding social responsibilities is ever present.

Religion

Religious beliefs amongst health care providers have been noted to influence the care given to patients. An observational cross-sectional study in Nigeria in 2014 showed that physicians' religious bias can affect practice [60]. Another cross-sectional study

in Massachusetts, USA, in 2016 among emergency physicians suggested that religious observance of a day of rest may play a role in reducing medical errors and malpractice lawsuits and reduce maladaptive coping behaviours which include smoking, alcohol consumption and substance use [61].

PNG is largely a Christian dominated country. The 2011 census showed that 95.5% are Christians and 4.5% are non-Christians [62]. Christianity is based on morality and respect for humanity. Although the doctrines of Christian churches vary greatly both within and between countries, there are four features of Christianity that are nearly universal: initiation (baptism), worship, ministry and 'good works'. A Christian's individual faith and religious practice will be influenced by the doctrine of the denomination (church) to which they belong as well as their own personal relationship with God. In PNG, not every Christian in the country actively practices his/her faith. Therefore, the relationship between this variable and practice is worth exploring.

Income

Every employed person works for one main purpose and that is some form of income. In PNG public healthcare providers are paid by the government. Income can influence how health workers practice in different ways to varying extents, as supported by studies around the world. A cross sectional study conducted in Cambodia in 2016 after a financial reform was introduced in 2009 concluded that health workers' income influenced their job motivation [63]. A mixed method survey from Zambia in 2017 show that performance-based financial schemes brought about significant increase in job satisfaction, but no significant effect in motivation [64]. In addition short term salaries, long term retirement financial incomes offered by the public sector has been shown to retain public healthcare workers [65]. In PNG, the influence of income has not been exhausted in detail, especially in terms of its relationship with practice regarding severe malaria, or any other diseases for that matter.

2.5.2.2 Professional Variables

Profession

With regards to health worker cadre, there is contradicting evidence with different health worker cadres in different countries and different studies. While some studies have shown

associations, others have not. Further still, the order of association has not been consistent. In some studies, higher cadre health workers have shown to be more likely to adhere to recommended practice, while in other studies lower cadre health workers have been found to be more likely to adhere to treatment guidelines. A meta-analysis based on papers from sub-Saharan Africa in 2016 showed that lower cadre health workers were more likely to comply with RDT results, while higher health workers may rely on past experiences and clinical diagnosis [66]. This finding agreed with some other studies. A cross sectional study in Tanzanian study done in 2013, assessing health worker cadre associated with correct antimalarial prescription for uncomplicated malaria, found that patients seen by a nurse or lower cadre health worker had significantly higher odds of correctly getting an ACT than patients seen by a medical officer [67]. Another cross-sectional study in Malawi also showed that nurses and medical assistants (lower than doctors) were more likely to prescribe correct first-line antimalarial drugs than medical officers [68]. A similar observation was made in a cross-sectional study in Kenya in 2004 where more specialised health workers such as doctors are more unlikely to comply with treatment guidelines than lower cadre when prescribing antimalarials to patients (53). This finding was also echoed in another cross-sectional study from Tanzania [67, 69].

However, other studies have shown otherwise. A study in Uganda found that doctors were more likely to conform to malaria treatment guidelines, in terms of malaria diagnosis and treatment, when compared to nurses [70]. A PNG study done in 2013 showed that community health workers sought diagnosis less than HEOs or nurses, and yet prescribed more antimalarial drugs [39].

On the contrary, there are studies which that found no association. Two cross-sectional studies by Delayano 2004 and Kakeeto etal. 2014 comparing the performance of higher level health worker cadres to lower cadres found minimal differences in outcomes to patients [71, 72].

Work experience

The relationship between work experience and practice regarding malaria case management has not been uniform. In addition, studies have found null association between the variables. A cross-sectional study in rural Tanzania in 2013 found that health workers with three or more years' work experience had significantly higher odds of correctly prescribing the recommended treatment, ACT [73]. On the other end, a PNG study in 2013 found that health workers with 20+ years of clinical experience sought diagnosis less and prescribed more recommended antimalarial while those with less than 20 years of clinical experience sought more diagnosis confirmation and prescribed according to results [39]. However, a cross-sectional study in Nigerian done in 2013 showed that work experience had no association with correct antimalarial prescription according to guidelines [58].

2.5.2.3 Knowledge

Knowledge among health workers specifically regarding severe malaria in the literature is negligible. Nevertheless, outlined below are mostly similarly structured studies on uncomplicated malaria in review. A study in Mozambique showed that good knowledge on diagnosis and appropriate treatment of malaria can strongly influence health workers' practice [74]. A mixed method study done in India from 2010 to 2015 in a tertiary teaching hospital assessing physicians' compliance to national policy showed that compliance of schizonticidal drugs against severe malaria was 73.0% and uncomplicated malaria was 9.5%, and compliance of gametocidal drug was 15.3%. The findings are not very impressive for the setting in which the study was conducted. The authors concluded that raising knowledge and awareness among health care providers by using continuing medical education and other methods would improve compliance [75].

A cross-sectional study in PNG on malaria case management following the rollout of a revised treatment protocol [21] in 2013 showed that a low knowledge level among health workers - RDT was done in 68.3% to of fever cases, 39.8% of RDT negative cases were prescribed an antimalarial, and 22.2% of the prescriptions were according to national guidelines [39]. However, the proceeding two similar studies on the same subject showed that health workers' compliance to the national malaria case management policy regarding uncomplicated malaria was higher than the previous study [40, 41]. The last study done in 2016 showed higher knowledge of health workers regarding uncomplicated malaria, which was associated higher compliance with national guidelines [40]. A similar trend (increasing knowledge with compliance) has been observed also seen in some other malaria endemic countries [53]. Up to date any similar data on severe malaria in PNG is lacking.

In endemic countries, malaria is not only treated in public facilities but also private facilities. A cross-sectional study in western Kenya assessing provider knowledge of treatment policy with AL and quinine found that public-providers have higher knowledge on treatment policy than providers in private facilities. Therefore the authors concluded that changes in nationals policies should be accompanied by activities involving all sectors in unbiased strategies so the knowledge can be widely disbursed [76].

2.5.3 INDIVIDUAL ATTITUDES AND PERCEPTIONS

2.5.3.1 Attitude

Attitude towards clinical practice

A cross-sectional study from Tanzanian in 2008 showed that the three main reasons why health workers' followed 'mind-line' instead of 'guidelines' was threefold: they thought malaria was easy to diagnose that alternate diagnoses; they thought missing malaria is indefensible; and they thought malaria is more acceptable diagnosis among peers and patients, and promoted by public health as an important disease [77]. Thus, they leaned towards malaria even with a negative RDT result when seeking alternative diagnoses was not to easy.

Multivariate results from a Kenyan study done in 2011 revealed higher likelihood of testing practices in facilities with both microscopy and RDT, than facilities with RDT only [78]. This indicated that the study clinicians did not believed in RDT and in some cases had to reconfirm results via microscopy. The same study revealed that fever patients presenting without cough, running nose and skin infection had significantly higher odds of a malaria diagnostic test done on them [78].

In a PNG study in 2016, the response to attitudinal questions was very positive, including 98.2% of health workers knowing that all patients who present with fever or suspected malaria should be tested for malaria infection by microscopy or RDT. The finding corresponded to an increase in compliance to the national guidelines [40].

Attitude towards responsiveness

Often time non-health needs of patients become less important when health workers put all the effort into solving patients' health problem. Nevertheless, meeting non-health needs does contribute to a quality health care. A cross-sectional study in Uganda in 2013 revealed that there was a huge need for health workers to recogise patients' rights, espacially in terms of reposnsives [79]. Another cross-sectional study published by academics from several universities in England showed that although physicians and other health workers showed higher levels of holistic approach (including responsive care), case load does affect holistics care practices. Thus, is was cocluded that interprofessional education and training strategies were needed to clarify and address professional differences and in holistics care [80]. These are studies in two different settings though not similar findings but do identify the gap for health to take non-health needs into consideration. Though this study is in reference to care for severe malaria patients, the finding will give a glimpse of a broader PNG picture.

2.5.3.2 Perceptions

Perceived Susceptibility

When health workers be feel that certain individuals are susceptible to severe malaria, it does influence practice. A qualitative study done in Tanzania in 2008 showed that

one of the main reasons for health workers doing over-diagnosis of malaria and over-prescription of recommended antimalarial drugs, despite negative results, was that they thought diagnosis of an important disease (malaria) cannot be missed [77].

Perceived Severity

How health workers feel how serious a patient's condition is can dictate practice, either within or without recommended guidelines. A cross sectional study in western Kenya in 2015 showed that children with laboratory-confirmed malaria negative but exhibiting danger signs were more likely to be treated with a parenteral antimalarial drug ($p<0.0019$) [81], and an antibiotic. A Malawian study showed that vomiting was one of the symptoms that influenced health workers prescribing antimalarial drugs despite a confirmed negative parasitological result [68]. WHO says that children with malaria who present with vomiting regardless of the presence of other dangers signs, start off with severe malaria treatment, until patient has settled, than continue with oral ACT [6, 21].

Perceived Barriers

Perceived impediments health workers have does influence how they practice. Doubting RDT results has been a common perceived barrier in many settings that has influenced health workers in different endemic countries. A cross sectional study from Tanzania done in 2016 showed that health workers thought significant portions of RDTs results were inaccurate or false results, thus, they prescribed antimalarials to RDT-negative patients [82]. Another cross sectional study done in Nigeria in 2016 showed that the main reason for non-usage of RDT among private healthcare workers was the perceived non reliability of RDT results [83], which corresponded to the low level of knowledge regarding malaria case management.

Occasionally, recommended antimalarial drugs are not prescribed when there is contraindication or caution, despite a positive parasitological test. A cross-sectional study done in Ugandan in 2013 showed that women of child bearing age (15 to 49 years) were had higher odds of not being prescribed the recommended ACT (artemether lumefantrine) [84] when health workers were cautious of pregnancy. A

PNG study in 2016 study looking at self-barriers for health workers to implementation of the national malaria treatment policy found that the commonest reason for health workers not to using RDT among health workers was absence of fever / malaria symptoms (expected symptoms), followed by nil stock of RDT [85].

Workload is a perceived barrier to health workers have in many settings. A study in Kenya in 2011 showed that case-load lower than 25 patients per day was associated with increased chances of a malaria diagnostic test being done on a patient [78].

Perceived Benefits

A randomised cluster trial in Ghana showed that career prospects, intrinsic incentives including cordiality with co-workers were significantly associated with positive heath workers motivation and quality output ($p = 0.000$). Another study in Uganda found that health workers who received an incentive performed better than those who did not [59].

Sometimes health workers perceive good reputation as benefits they get from the community. Studies have showed that sometimes health workers gave positive results to RDT-negative patients to please patients and to safeguard their reputation because negative result was sometimes viewed as the health worker being incompetent [82, 86].

Health workers' perception that a certain procedure is beneficial for patients can influence practice. A study in Nigeria in 2011 showed that health workers believed RDT results and prescribed antimalarials accordingly because they perceived that it gave reliable results and made their jobs easy [87]. A quasi-experimental study in Ghana done in 1996 showed that health workers preferred injection antimalarial drugs and poly-pharmacy mainly influenced by socio-cultural factors which included stereotyping and prescriber self-interest [88].

Perceived Self-efficacy

A survey done in Kentucky University, USA, in 2011 to understand the relationship between self-efficacy and evidence-based practice (EBP) based on the background

that EBP was often underutilised by individual clinicians. That study showed that promoting self-efficacy in clinicians directly promoted acquisition and application of evidence, and indirectly encouraged communication between clinicians to justify and reinforce new knowledge [89]. Health workers may acquire new knowledge, but without self-confidence, it is underutilised.

A qualitative study done in Ethiopia in 2016, looking at the perspective of primary health care workers, showed that one of the main reason deterred primary health care workers from using injectable artesunate to treat severe malaria patients was the fear of irrational drug use [90]. They knew about the recommended antimalarial drug but lacked confidence in administering it to patients. The same study further demonstrated that health extension workers at primary health-care facilities thought that they were not skilful enough, like medical officers, to manage severe malaria [90].

2.5.4 CUES TO PRACTICE

Training

The association of training and practice regarding malaria has not been consistent, differing country to country, or study to study. Some studies agree while others do not in having job-aids within clinics. A cross-sectional mixed method study done in Uganda in 2016 found that health workers who attended a training that lasted 2 – 3 days were more likely to perform better than those whose training lasted 3 – 5 days [59]. Another clustered-randomised control trial conducted in Nigeria in 2008 noted improved diagnosis and treatment practices regarding malaria in the training (intervention) group than the control group [91]. The findings in a clustered-randomised control trial done in Cameroon in 2014 was interesting, while showing no significant increase in health workers prescribing antimalarials according to treatment guidelines among the two training interventions and control groups, the study showed a significant reduction in unnecessary use of antimalarial drugs in patients with negative results [92]. Not prescribing antimalarial drugs to RDT negative patients is a recommended practice [6].

In contrast, a Tanzanian cross sectional health facilities survey showed that in-service training and supervision were not associated with prescribing ACT [67]. Another

Kenyan study done in 2011 also showed no association between access to malaria guidelines and case management [78] after a one-off training. A Malawian study found that after recently receiving malaria case management training, >50% of suspected severe malaria patients were given oral ACT without a diagnostic test [93].

A cross sectional study done in Nigeria in 2016 showed that there was no association between training on malaria case management and health workers' adherence to national treatment guidelines [83]. A study in Tanzania assessing health workers performance in children under 5 observed that staff trained in IMCI and no malaria guideline treatment were more likely to over-diagnosis and overtreat of malaria [94], though performing well in management of overall sick child.

Since the adaption of a revised treatment policy in 2011, PNG has had annual health facility surveys monitoring how health workers were complying to the national guidelines. Before roll-out of the new treatment policy, then, there was a wide national training conducted. The progressive surveys show that 2 – 3 years following, compliance not been very good [39]. However, in the last survey of 2016 80% [41]. This may suggest that the effect of trainings may take time to penetrated strongholds of health workers long used to older regimens and ways of practice.

Availability of RDT/Microscopy

The availability of diagnostic modalities or appropriate drugs can have influence on health workers' practice regarding malaria case management. A cross sectional in Kenya done in 2014 showed that when RDT was available, the parasitological diagnosis rate went up [95]. Other studies also showed that the percentage of patients prescribed recommended antimalarial (ACT) depended on the availability of RDT and the appropriate drug(s) [95, 96]. Two different cross-sectional studies, one from Nigeria and another from Tanzania showed that health workers who confirmed their diagnosis via RDT or microscopy were significantly more likely to adhere to national treatment guidelines [82, 83]. A study in Mozambique showed that RDT was used when it was in-stock, but when there was stock-out all patients were clinical diagnosed and dispensed antimalarial drugs [74].

However, some studies have shown the other side other side of the picture. A cross sectional study in Tanzania showed that stock-outs of RDT was amongst the least reasons for non-compliant to guidelines [82].

Access to National Malaria Treatment Policy and Related Material

Interestingly, the presence of job aids, including treatment guidelines and algorithms, seems to have negligible association with practice regarding malaria in many studies. A study done in Nigeria done in 2016 showed that access to guidelines was not associated with health workers' adherence to national treatment guidelines [83]. Another study in Malawi in 2017 showed that health workers perceived guidelines to be a proposition rather than evidence-based recommendations that demanded adherence [93], therefore were not complaint to guidelines. Some studies have shown that neither supervision nor guidelines alone were associated with health worker practices [97-99]. A clustered-randomised control trial conducted in Nigeria in 2008 showed that there is limited usefulness in having clinical algorithms within primary health facilities [91].

Availability of Appropriate Drugs

A study in Mozambique showed that when there was ACT stock-out, positive patients were sent to the nearest health facility to collect their recommended antimalarial drugs [74], which simply shows that unavailability of the recommended drug can result in patients not being appropriately. Studies have shown that availability of obsolete antimalarial drugs (or regimens) without the availability of the recommended drugs can cause health workers to deviate from national guidelines [40, 100]. Many other studies also showed that the percentage of patients prescribed recommended antimalarial (ACT) depended on the availability of RDT and the appropriate drug(s) [95, 96]. Another study in Nigeria also showed that the availability of antimalarial drugs was a major factor that affected treatment prescription. [83].

Supervision

A study done in Uganda assessing performance of community health workers (CHW) regarding malaria, pneumonia and diarrhoea showed that the CHWs who met with their supervisors the previous month were more likely to score above 50% (good according to the criteria of the study) compared to those who do not meet with their supervisors [59]. Another study also in Uganda in 2011 where a surveillance centre was set up in health facilities and health work continuously monitored showed the rate of parasitological diagnosis improve from 65% to >95%, though ACT compliance did not follow due to stock out [101]. While surveillance in every health facility in a country may not be possible, it provides an indication that a similar model with ongoing supervision can make a huge difference in improving malaria case management. However, there are studies which have shown that there is no association between supervision and case management of malaria [73].

There are two forms of supervision; controlled supervision and supportive supervision. The difference them are follows:

Controlled supervision – focus on finding faults, supervisor is like a policeman, episodic-problem solving, little or no follow-up, punitive actions intended. This has been the traditional approach of supervision employed by many countries. It uses an authoritarian, inspection, or control approach to supervision. The approach is based on the thinking that health workers are unmotivated and need strong outside control to perform correctly. However, it has been shown that a supportive approach, where supervisors and health workers work together to solve problems and improve performance, delivers improved results [102].

Supportive approach – focus on improving performance and building relationships, more like a teacher, coach, mentor, use local data to monitor performance and solve problems, follow-up regularly, only support provided. Supportive supervision helps staffs to improve their own work performance continuously. It is carried out in a respectful and non-authoritarian way to improve knowledge and skills of health staff

[102]. If carried out properly, supportive supervision can lead to: higher health worker motivation; increased and sustained job satisfaction; improved service quality, as staff learn and improve skills on-the-job; efficient use of resources, as staff are supported to prioritise activities and allocate resources accordingly; enhanced equity in access to services, as staff are reminded of the health needs of the population and encouraged to work towards meeting these needs [103]. Health systems across the Pacific, including PNG, experience a number of key obstacles to practising supportive supervision: lack of clear policy on supervision; budgetary constraints; inadequate skills for supportive supervision; low motivation; lack of transport and logistics; heavy load [103].

Data Feedback

Results from a cross sectional study done in Uganda in 2013 demonstrated that with periodic feedbacks where data was shared with outpatient clinicians and malaria case management was tracked in addition to additional training, all malaria suspects received a diagnostic test and 94.5% of confirmed cases received the recommended antimalarial drug (ACT) [84]. This was quite an achievement in an outpatient setting.

2.5.5 PRACTICE REGARDING SEVERE MALARIA

Diagnosis of severe malaria

Prompt and accurate diagnosis of malaria is part of effective management of severe malaria. The signs and symptoms of severe malaria are non-specific. WHO recommends that all patients with suspected malaria, or severe malaria, should be treated on the basis of confirmed parasitological diagnosis by RDT or microscopic examination [6]. Correct diagnosis is particularly important for vulnerable population, including children under 5 years and pregnant women, in whom severe malaria can be rapidly fatal [6]. High specificity will reduce unnecessary treatment with antimalarial drugs and improve the diagnosis of other febrile illnesses in all settings. The last health facility done in PNG has shown that health workers have improved a lot in using RDT to diagnosis uncomplicated malaria [41]. However, no PNG data is available on diagnostic practices of severe malaria.

A delayed or missed diagnosis on the other hand can prove to be devastating. A case-study of a Japanese returning from Nigeria where malaria was misdiagnosed for

common cold saw the patient developing very severe disease [104]. Though the patient recovered, it was with much advanced therapy in a higher dependency unit. Studies have shown over-diagnosis can result in wastage or abuse of antimalarial drugs [66], while correct diagnosis is cost-effective [105].

Treatment of severe malaria

It is essential that full doses of effective parenteral (or rectal) antimalarial treatment is given promptly in the initial treatment of severe malaria. Mortality from untreated severe malaria approaches 100% [6]. Two classes of medicine are available for parenteral treatment of severe malaria: artemisinin derivatives and cinchona alkaloids (quinine and quinidine) [6]. The largest clinical trials ever conducted on severe malaria showed substantial reduction of morality with artesunate injection as compared with quinine [106]. PNG has adopted artesunate injection has her first-line treatment for severe malaria since 2011 [21].

Follow-up of discharged severe malaria patients

Following up patients after discharge not only completes patient management but is very important, especially for discharged severe malaria patients where parasite clearance needs monitoring in patients with high parasite counts. A multicentre observational study in different sites across Europe showed that three patients died before day 28 post-treatment and 19/70 (27%) developed post-artemisinin delayed haemolysis [107]. At a time when artemisinin resistance is emerging of which hyperparasitaemia is risk factor, follow-up of discharged severe malaria patients becomes more important.

A cross-sectional study in Zimbabwe in 2017 showed that additional deaths occurred because efforts put towards complete management of severe malaria, including monitoring was inadequate [108].

2.6 Health Belief Model (HBM)

The HBM was developed in the early 1950's at the US Public Health Service. It is a conceptual framework used to understand health behaviour and possible reasons for

health-related behaviours and non-compliance with recommended health action. The underlying ideology of original HBM is that health behaviour is determined by personal beliefs or perceptions about a disease and strategies to reduce occurrence [109, 110]. HBM contains several constructs that predict the way people will take action to prevent, to screen for, or to control diseases.

People tend to behave in certain ways the when they perceived that certain actions are beneficial, in view of barriers, and self-confidence from within. Some researchers have made modifications in different ways to suit their objectives. One study has added 'attitude' to the constructs [111]. This study will also modify HBM.

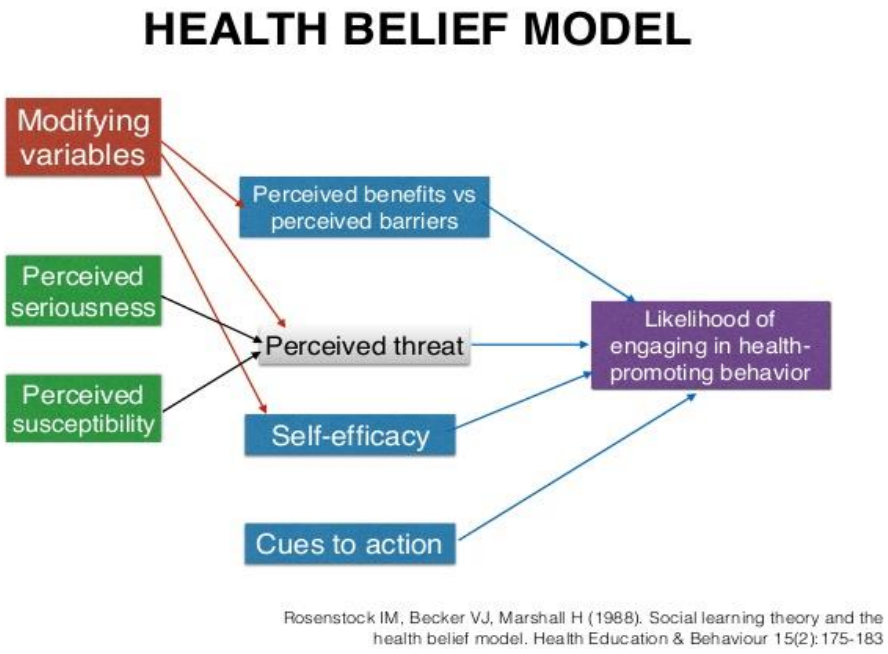


Figure 2: The Health Belief Model

The constructs of HBM are as follows [109]:

Perceived susceptibility – refers to subjective assessment that an individual is at risk of developing a health problem.

Perceived severity - an individual's belief about how serious a condition and its sequalae is.

Perceived benefits is an individual's belief that an advised behaviour will reduce the risk of getting a disease.

Perceived barriers - an individual's negative beliefs about what will stop him or her from performing an advised behaviour.

Cues to action – refers to factors or strategies that will enable an individual to think along the line of practicing an advised behaviour.

Self-efficacy - an individual's confidence in his or her ability to take action.

2.7 Likert Scale

Likert scale are a non-comparative scaling technique used in questionnaires to obtain participant's degree of agreement with a statement or set of statements. The founder of the scale was Dr Rensis Likert, a sociologist at the University of Michigan, who developed the technique in 1932 to measure attitudes. The scale has been used in studies about perceptions [112]. The commonly seen is a 5-point scale ranging from "strongly disagree" on one hand to "strongly agree" on the other. At the middle is an indifferent option. However, 5-point scales have certain concerns according to some academics from University of Wollongong, Australia [113]:

1. Response style bias (centrally tendency bias). Response biases can occur where respondents may display independent of the content of the questions or may have the tendency to go for the indifferent option more often.
2. Takes longer to complete.
3. There is no good explanation for the current dominance of the five and seven-point Likert items. Simpler, quicker, easier and more valid measures could be used without loss of predictive validity.

In addition, the Malaria Behaviour Change Communication (BCC) Indicator Reference Guide expresses 5-point scale, states that the interview must NOT use the neutral reason, apparently to avoid central tendency bias [114]. In this study, 4-point Likert scale is used.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Research Design

This was a quantitative cross-sectional study.

3.2 Study area and population

PNG is made up the eastern half of the island of New Guinea and over 600 smaller islands divided into 22 provinces and 4 regions. New Guinea Islands Regions has 5 provinces, Momase Region has 5 provinces, Highlands Region has 6 provinces, and Southern Region has 5 provinces. The Central Province (province) is located in the Southern Region, which, as the name suggests, lies along the southern coastline of PNG. The province partly extends into the capital city, Port Moresby. The vegetable is part savannah grassland and part rain forest, with patches of swamp. Economic activity is mainly subsistence agriculture, hunting and fishing. Some families have employed members who support them.

Figure 3: PNG map showing location of Central Province (Getty images).

CP is made up of four electorates (districts); Kairuku Hiri, Rigo, Goilala and Abau. According to the last census (2011), the population of Central Province was 269,756 [62]. As off 2016, the operating primary health facilities in CP are as follows:

DISTRICT	**HEALTH CENTRE**	**AIDPOST SUPERVISEE**
Abau	Boru SC	Magaubu, Darava.
	Iruna HC	Mailu Island, Bailebo, Aroana.
	Kupiano HC	Paramana, Wairavanua, Wanigela,
	Moreguina HC	Cocoalands, Domara, Manabo, Apaeva, Ianu, Merani.
Rigo	Hula HC	Kalo, Kaparoko, Kwaipo, Meirobu, Matairukua, Dirinomu.
	Boku HC	Homenomu, Nogomaka.
	Kwikila HC	Alepa, Dubanatepo, Varogokena, Launakalana, Kemabolo, Sivitatana, Gabagaba, Manugoro, Galomarubu, Taurubu, Imoagoro, Londari, Toule, Saroa, Maipiko, Ganugau.
Hiri	Sogeri HC	Ogotana, Doe, Kailaki, Sogeri Nat. High, Veselogo, .
	Efogi SC	Manari, Kagi, , Naduri.
	RMC	Gaire, Mt. Diamond, Roku, Kido, Manumanu, .
	Porebada HC	Boera.
Kairuku	Agevairu HC	Vanuamai, Avabadina, Pinu.
	Bereina HC	Boitau, Apanaipi, Kivori Poe, Babiko, , Delena.
	Bakoidu HC	Kubuna.
	Veifa's HC	Kanosia, Inawi, Mainohana Sec., Inawaukiana, Inauaoni.
	Doa HC	Doa Factory, Veimauri.
Goilala	Fane HC	Kerau, .

	Tapini HC	Sopu, Kofea (Cl), Omu, Lavavai, Rupila, Erume.
	Kamulai HC	Unekome.
	Woitape HC	Aikora, Kodige, Kone, Kambise.

Facilities noted to have been closed or inconsistently operating at the time of survey were as follows: Borebu Aid Post, Kapari Aid Post, Waiori Aid Post, 15 Mile Aid Post, Boridi Aid Post, Gorohu Aid Post, Oriropetana Aid Post, Gaiva Aid Post, Guarimaipa Aid Post, and Suasi Aid Post.

For this study, only health centres (10) were selected.

Inclusion criteria

- Medical doctors, HEOs, nursing officers and CHWs at the facility on interview day.

Exclusion criteria

- Refusal to participate
- Unable to write due to disabilities or injuries

3.3 Sample size

The Cochrane formula was used to calculate the sample size for this study.

$$\mathbf{N = Z^2 p\,(1\text{-}p) / d^2}$$

N = required sample size
Z = reliability coefficient at 95% CI (1.96)
p = estimated proportion of attribute in the population (50%)
d = the acceptable error (0.05).

$$N = \frac{1.96^2 \times 0.5 \times (1 - 0.5)}{(0.05)^2} = 384$$

As the required number of sample size was not feasible to fulfil, the finite correction formula was used to reduce the figure:

Finite Population Correction Factor

If the population is small, a finite population correction factor can be applied. This will reduce the sample size required *(Rose, Spinks, Canhoto, 2015; Israel, 2012)*.

$$n_a = \frac{n_r}{1 + \left(\frac{n_r - 1}{N}\right)}$$

Where n_a = the adjusted sample size, n_r = the original required sample size and N = population size:

$$n_a = \frac{384}{1 + \frac{(384 - 1)}{450}} = \textbf{142, adjusted minimum sample size}$$

Including an additional 10% to make up for refusal to participate and faulty questionnaire, the total sample size would have been 156. However, due to logistical and time constraints the researcher settled for 142 participants.

3.4 Sampling technique

Multi-stage sampling was used in this study.

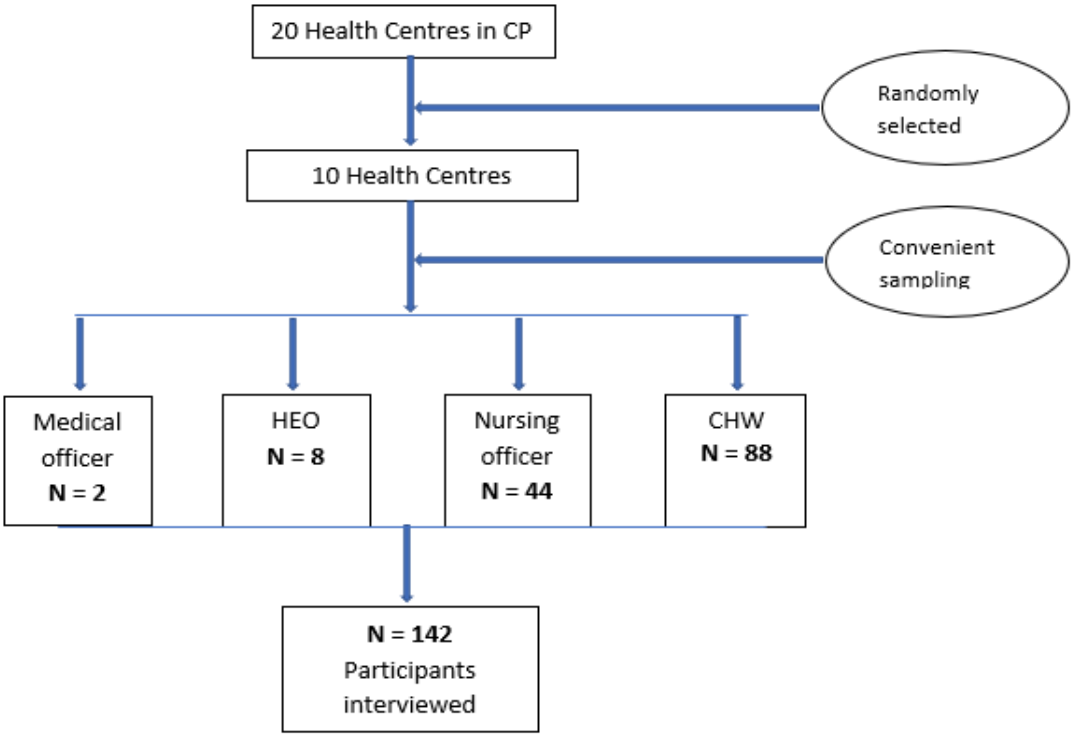
Stage 1: Firstly, 10 health centres were randomly selected from the 20 health centres throughout CP. The health facilities visited during the study were Moreguina HC, Kupiano HC, Goldie Barracks Medical Centre, Kwikila HC, Sogeri HC, Papa HC, Bereina HC, Veifa'a HC, Inawaia HC, and Agevairu HC.

Stage 2: The proposed plan was to do a proportional sampling. However, since circumstances on the ground did not permit, convenience sampling was applied – health workers who were present on the interview day were handed the questionnaire to fill. The number and proportion of health workers covered were as follows:

Medical doctor	= 2 (1.4%):	Total in the 10 health facilities.
HEO	= 8 (5.6%):	Total in the 10 health facilities.
Nursing officer	= 44 (31.0%):	Total in the 10 health facilities.
CHW	= 88 (62.0%):	Total in the 10 health facilities.

Out of all the 10 facilities covered during the study, only 2 facilities had a doctor each.

Figure 4**:** Sampling flow diagram



3.5 Measurement instrument

Data was collected via self-administered questionnaires. The questionnaire was divided into three main parts as follows: Part 1 – Modifying variables; Part 2 – Individual Attitudes and Perceptions; and Part 3 – Cues and Practice Regarding Severe Malaria. Cues and practice were combined into one section to make the flow easy for respondents and avoid confusion. It proved to work out well during the study.

3.5.1 Components of the Measurement Instrument

3.5.1.1 PART 1: MODIFYING VARIABLES

Socioeconomic section

This section consisted of sex, age, marital status, religion, social roles and income. There were seven questions on socioeconomic variables, 1.1.1 to 1.1.7. The questions

on age was an open-ended, but for analysis it was categorised into four groups - <20 years, 20 – 35 years, 36 – 50 years and >50 years. The rest were closed-ended questions. All the questions were derived from literature.

Professional section

This was a sub-section under Part 1 which consisted of health worker cadre, work experience and tertiary institution attended. Questions on professional variables are from item 1.2.1 to 1.2.3. Work experience and tertiary institution were open-ended questions. The question on selection of health worker cadre was a close-ended one. All questions in this section were derived from literature.

Knowledge section

This section consisted of 15 items, from 1.3.1 to 1.3.15. There was only one correct answer to each question which was marked 1 during data entry. Any other answers got 0. All questions were closed-ended. The questions were derived from literature and PNG national malaria treatment policy guideline.

3.5.1.2 PART 2. INDIVIDUAL ATITUDES AND PERCEPTIONS

Attitudes.

Attitude section was divided into two sections; attitude towards clinical practice and attitude towards responsiveness. Section 2.1 was on attitude towards clinical practice and had 7 statements from 2.1.1 to 2.1.7. All items were derived from literature. Four were positive statements and three were negative statements. The negative statements were scored through reverse coding.

Section 2.2 was on attitude towards responsiveness and also had 7 statements from 2.2.1 to 2.2.7. All items were derived from literature. The negative statements had reverse coding and scored accordingly during data entry.

Participants responded to the attitudinal statements on a 4-point Likert scale with options: strongly agree, agree, disagree and strongly agree. The neutral options usually found five or higher odd-numbered Likert scales was disregarded to avoid biased responses.

Perceptions

This section was divided into five sections; perceived susceptibility (2.3.1 to 2.3.5), perceived severity (2.4.1 to 2.4.5), perceived barriers (2.5.1 to 2.5.5), perceived benefits (2.6.1 to 2.6.5) and perceived self-efficacy (2.7.1 to 2.7.5). Participants were also provided with a 4-point Likert scale to mark their responses.

3.5.1.3 PART 3. CUES AND PRACTICE REGARDING CASE MANAGEMENT OF SEVERE MALARIA

This section had a total of 23 closed-ended questions. Nine questions were regarding cues and 14 questions were regarding practice. Corresponding question numbers for cues were 3.1, 3.3, 3.4, 3.5, 3.7, 3.9, 3.17, 3.19, and 3.20. And questions numbers corresponding to practice were 3.2, 3.6, 3.8, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, 3.16, 3.18, 3.21, 3.22, and 3.23. Questions on cues and practice were combined to make flow convenient for respondents. For example, all questions regarding cues and practice on RDT were put one after another to make the flow coherent. There was only one positive answer to each question which was accorded 1 during data entry and analysis. Any other answers were marked '0'.

3.5.2 Validity and Reliability

Construct validity

The questionnaire corresponded with layout of the conceptual framework which was based on the health belief model. Operational definitions were matched with conceptual definitions based on literature. The construct was validated by malaria experts.

Content validity

Every item included in the questionnaire was derived from literature and PNG national malaria treatment policy guidelines and therefore were raw, so they were validated by malaria experts identified below. The calculated index of item-objective congruence (IOC) score was 0.78 [115].

Experts engaged in validating items of the questionnaire:

1. Dr Tepanata Pumpaibool - BSc (Microbiology), MSc (Industrial Microbiology), PhD (Biomedical Science). Dr Tepanata was a serving academia at College of Public Health Sciences, Chulalongkorn University, and had involved in malaria research over 10 years at the time of this study.

2. Dr Livingstone Tavul - BSc, MSc, PhD, Senior Research Fellow & Laboratory Head, VBDU, PNG Institute of Medical Research. Dr Tavul has had over 20 years' experience in malaria research at the time of study.

3. Mr Leo Makita – BSc, MEE, VB, BM, DPH, DMM, DAP&E, MPH. Mr Makita had worked within malaria field for over 30 years. Over those years he had had many publications, and he continues to contribute towards malaria research with his extensive knowledge and experience. He was the serving Program Manager for Malaria and Vector Borne Diseases at Ministry of Health in PNG at the time of this study.

The calculated IOC score was 0.85.

Face validity

Face validity was checked during pilot testing – details of which are mentioned below.

Pilot testing

Pre-testing of the questionnaire was conducted in a pilot study to check comprehension of the respondents, duration to complete the questionnaire, flow of the questions and to see if there were any sensitive or offending wordings that would demotivate respondents.

The target sample for pilot testing was 30 respondents. However, due to circumstances beyond the control of the researcher, 14 respondents were included in the pre-test. The main reason was that the local ethical committee recommended for a change in study site – from the initially planned urban setting to a rural setting. Arranging logistics took most of the time allocated for data collection. To compound the problem, health workers in a hospital where the pilot test was planned to be provided, refused to fill the questionnaire after receiving advise from a senior medical

officer. The researcher could not afford to use up any more staff for pilot testing due to geographical toughness, time constraint and sparse distribution of staff in the isolated facilities of the selected rural province.

Nevertheless, it was a coincidence that 14 participants for pilot testing equates to 10% of the total sample size (142), which is acceptable [116]. Therefore, the pilot-testing is valid.

Reliability

After pilot testing, internal consistency of the items was conducted reliability test function of SPSS 22.0. For dichotomous items, namely knowledge, the computed Kuder-Richardson 20 (KR-20) score was 0.721. For scale items, namely attitudes and perceptions, the computed Cronbach's alpha scores were 0.68 (0.7) and 0.73 (0.7). [117]. After completing the actual data collection, another set of reliability test was conducted and the Cronbach's alpha scores for attitude and perceptions were 0.73 and 0.81 respectively.

3.6 Data collection

3.6.1 Administrative Processes

Before the research began, the principal researcher wrote an official letter to the office of the Provincial Health Advisor (PHA). A PHA is the head of public health sector in a province in PNG. Following the letter, a courtesy visit was made and the PHA, having recently graduated with a Master of Public Health degree, was impressed and granted permission forthwith. Following the approval from the PHA, communication was established with the Provincial Disease Control Officer (PDCO) to get the message out to all selected facilities. Tentative interview dates were set which had to be deferred due to logistical delays. The facilities were still reached afterwards.

3.6.2 Training of Research Assistant

A female HEO who has clinical experience background and now working with the National Malaria Program was selected to be the research assistant. A day's training was conducted by the principal researcher at Ministry of Health. Contents of the training comprised of the national malaria case management guideline booklet and a

hard copy of the study proposal, with much focus on information sheet, consent forms and the questionnaire. The method of training was mostly face-to-face communication lecture. At the end of the training, a simulation exercise was conducted to assess the research assist. There was sufficient discussion during the session to ensure that the research assistant was confident. Stipend was in order for the research assistant.

3.6.3 Interview

On the days of interview, below are basically the steps that were taken;

1. After reaching a health facility, the OIC was approached and brief awareness regarding study. It was highlighted that the study was for a MPH project. However, if they were interested, assurance was given that interesting findings would be provided in the near future. It was further reiterated questionnaires were not meant to judge or make anyone feel guilty. Reassurance was repeated that every information collected would be kept strictly confidential.
2. After debriefing with the OIC, questionnaires were distributed to all staff available at work on that day. Those who were willing to take part and agreed on the consent form were allowed to pursue with completing the questionnaire. In some facilities, the principal researcher or assistant would wait around for the participants to complete filling the questionnaire. In others, questionnaires were left with the participants and advised to return completed questionnaires to the OIC to keep and were picked up later on the same day after visiting other health centre(s), or day(s) later.
3. The questionnaires were cross checked during re-collection. Queries were addressed as appropriate.

3.7 Data Entry and Data analysis

Data was first entered into Microsoft excel. After cross checking and necessary adjustments done, data was then transferred into SPSS 22.0 for analysis.

MODIFYING FACTORS

Sex: This item was grouped into two groups, male and female, and analysed.

Age: This information was acquired with an open-ended question and later categorised into four groups for analysis: <20 years; 20 – 35 years; 35 – 50 years and >50 years. However, while doing descriptive analysis it was realised that none of the participants were below 20 years, and so this category had no role in further statistical analysis.

Marital status: This information was collected under four categories: married; never married; divorced/separated; and widowed. However, during descriptive analysis it was noted that more than 80% were married, causing a skewed. Therefore, for statistical analysis marital status was grouped into two groups, married and single (never married, divorced/separated, widowed).

Income: This information was obtained in three categories: <K500; K500 – K1000 and >K1000.

Profession: This information was obtained under four categories; medical officer (MO) nursing officer, health extension officer (HEO) and community health worker (CHW). However, during descriptive analysis it was noted there were only two MOs and eight HEOs, giving rise to a grossly disproportionate data. To help reduce skewed distribution, MOs and HEOs were put into the same category. This reclassification is justifiable because both professions are acquired through a fours degree program. HEOs are trained above nurses and some are very smart. In addition, it was noted in prior analysis that MOs and HEOs generally responded to the questionnaire items in the similar fashion.

Knowledge: This information was obtained via close-ended questions and put into three groups according to Bloom's criteria: poor knowledge (< 60%), moderate knowledge (60 – 80%) and high knowledge (> 80%).

INDIVIDUAL ATTITUDES AND PERCEPTIONS

Attitude towards clinical practice: This section covered items from 2.1.1 to 2.1.7. It had seven statements, of which four were positive and three were negative statements. Participants provided their responses on a 4-point Likert scale which ranged from strongly agree, agree, disagree and strongly disagree (in order). Positive statements

had forward scoring while negative statements had reverse scoring. That meant that the higher the score, the more positive the attitude.

The total score of the seven items ranged from 7 to 28. The standard deviations on either side were used as cut-offs to classify attitude to clinical practice into three groups as follow:

Negative attitude	- scores ≤ mean – SD
Neutral attitude	- mean – SD < score < mean + SD
Positive attitude	- scores ≥ mean + SD

Attitude towards responsiveness: This section covered items from 2.2.1 to 2.2.7. It had seven statements, of which four were positive and three were negatives statements. Participants provided their responses on a 4-point Likert scale which ranged from strongly agree, agree, disagree and strongly disagree (in order). Positive statements had forward scoring while negative statements had reverse scoring. That meant that the higher the score, the more positive the attitude.

The total score of the seven items ranged from 7 to 28. The standard deviations on either side were used as cut-offs to classify attitude to clinical responsiveness into three groups as follows:

Negative attitude	- scores < mean – SD
Neutral attitude	- mean – SD < score < mean + SD
Positive attitude	- scores ≥ mean + SD

Perceived susceptibility: This section covered items from 2.3.1 to 2.3.5. It had five statements, of which three were positive and two were negative statements. Participants provided their responses on a 4-point Likert scale which ranged from strongly agree, agree, disagree and strongly disagree (in order). Positive statements had forward scoring while negative statements had reverse scoring. That meant that the higher the score, the more positive the perception.

The total scores ranged from 4 to 20. The mean was used as cut-off to classify perceived susceptibility into two groups as follows:

1. Low - less than mean (score < mean)
2. High - greater than or equal to mean (score ≥ mean)

Perceived severity: This section covered items from 2.4.1 to 2.4.5. It had five statements, of which two were positive and three were negative statements. Participants provided their responses on a 4-point Likert scale which ranged from strongly agree, agree, disagree and strongly disagree (in order). Positive statements had forward scoring while negative statements had reverse scoring. That meant that the higher the score, the more positive the perception.

The total scores ranged from 4 to 20. The mean was used as cut-off to classify perceived susceptibility into two groups as follows:

1. Low - less than mean (score < mean)
2. High - greater than or equal to mean (score ≥ mean)

Perceived barriers: This section covered items from 2.5.1 to 2.5.5. It had five negative statements. Participants provided their responses on a 4-point Likert scale which ranged from strongly agree, agree, disagree and strongly disagree (in order). All the negative statements had reverse scoring. That meant that the higher the score, the more negative the perception.

The total scores ranged from 4 to 20. The mean was used as cut-off to classify perceived susceptibility into two groups as follows:

3. Low - less than mean (score < mean)
4. High - greater than or equal to mean (score ≥ mean)

Perceived benefits: This section covered items from 2.6.1 to 2.6.5. It had five statements, of which three were positive and two were negative statements. Participants provided their responses on a 4-point Likert scale which ranged from strongly agree, agree, disagree and strongly disagree (in order). Positive statements had forward scoring while negative statements had reverse scoring. That meant that the higher the score, the more positive the perception.

The total scores ranged from 4 to 20. The mean was used as cut-off to classify perceived susceptibility into two groups as follows:

1. Low - less than mean (score < mean)
2. High - greater than or equal to mean (score ≥ mean)

Perceived self-efficacy: This section covered items from 2.7.1 to 2.7.5. It had five positive statements. Participants provided their responses on a 4-point Likert scale which ranged from strongly agree, agree, disagree and strongly disagree (in order). Positive statements had forward scoring. That meant that the higher the score, the more positive the perception.

The total scores ranged from 4 to 20. The mean was used as cut-off to classify perceived susceptibility into two groups as follows:

1. Low - less than mean (score < mean)
2. High - greater than or equal to mean (score ≥ mean)

Cues to Practice: There were nine questions on cues to action. Each question had one favourable answer which was scored '1'. Unfavourable responses were score '0'. The total score for each participant ranged from 0 to 9. They will be categorized into two groups using the mean as reference point;

1. Favourable - Score < mean score
2. Unfavourable - Score ≥ mean score

Practice Regarding Severe Malaria: There were fourteen questions on practice. However, questions 3.14, 3.16 and 3.22 were follow-up questions to wrong answer, thus they do not carry any points (They can be utilised later to explore why the participants did those wrong practices). Each question had one favourable answer which was scored '1'. Unfavourable responses were score '0'. Practice was divided into four components: overall practice, diagnostic practice, treatment practice and follow-up. The total score for overall practice ranged from 0 to 11. Every question on practice referred to one of the three components – diagnosis, treatment or follow up. To calculate the level of each component, item corresponding to each component was extracted and scored accordingly. Each component was then categorized into two – compliant or non-compliant – according to the national malaria treatment guideline. The mean scores were used as the reference point:

Overall practice (0 – 11)

Complaint - Score < mean score

Non – compliant - Score ≥ mean score

Diagnostic practice (0 – 3)

Complaint - Score < mean score

Non – compliant - Score ≥ mean score

Treatment practice (0 – 6)

Complaint - Score < mean score

Non – compliant - Score ≥ mean score

Follow up (0 – 2)

Complaint - Score < mean score

Non – compliant - Score ≥ mean score

3.7.1 Descriptive statistics

Descriptive statistics performed are summarised in Table 4.

Table 4: Descriptive Statistics Applied in the Study

VARIABLES	**VARIABLE TYPE**	**DESCRIPTIVE STATISTICS**
Sex	Categorical (Discrete)	Frequency, Percentage
Age	Categorical (Discrete)	Frequency, Percentage
Marital status	Categorical (Nominal)	Frequency, Percentage
Religion	Categorical (Nominal)	Frequency, Percentage
Social roles	Categorical (Nominal)	Frequency, Percentage
Income	Categorical (Ordinal)	Frequency, Percentage
Knowledge	Categorical (Nominal)	Frequency, Percentage
Attitudes - Attitude to clinical practice - Attitude to responsiveness	Categorical (Ordinal)	Frequency, Mean, SD, Percentage
Perceptions - Perceived susceptibility - Perceived severity - Perceived barriers - Perceived benefits - Perceived self-efficacy	Categorical (Ordinal)	Frequency, Mean, Percentage
Cues to practice	Categorical (Nominal)	Frequency, Mean, Percentage
Practice - Overall practice, - Diagnostic practice - Treatment practice - Follow-up	Categorical (Nominal)	Frequency, Mean, Percentage

3.7.2 Inferential statistics

For bivariate analysis, association between each independent variable and dependent variable were analysed by bivariate analysis using Pearson's Chi-square test with p-value cut off of 0.05. For cell frequencies < 5, Fisher's exact reading was taken.

For multivariate analysis binary logistic regression was used. Outcomes of the dependent variable were dichotomous; compliant and non-compliant. Independent variables put into the multivariate analysis were those variables that were significant at P value <0.2 in bivariate analysis or variables that were significant in other studies despite (even not statically significant at 0.2 level in bivariate analysis). Confidence interval was set at 95%. B-coefficient and odds ration were used to identify the direction of association.

Table 5: Inferential Statistics Applied in the Study

Independent variables	Dependent variables	Bivariate analysis	Multivariate analysis
MODIFYING VARIABLES - Sex - Age - Marital status - Religion - Social roles - Income - Profession - Work experience - Knowledge	PRACTICE REGARDING SEVERE MALARIA (Overall practice, Diagnosis, Treatment, Follow-up); Binary outcomes - Compliant - Non-compliant	Chi-square test Fisher exact reading where cell frequency was < 5	Binary logistic regression
INDIVIDUAL ATTITUDES AND PERCEPTIONS - Attitude to clinical practice - Attitude to responsiveness - Perceived susceptibility - Perceived severity - Perceived barriers - Perceived benefits - Perceived self-efficacy			
CUES TO PRACTICE			

3.8 Ethical Consideration

Ethical approval to conduct this study was obtained from the Papua New Guinea Medical Research Approval Committee (PNG MRAC). This ethical committee recommended for the study site to be changed – from an initially planned urban setting to a rural setting – which was adhered to.

The decision to take part in the study was entirely voluntary. Participations signed a written consent after being informed of the nature of the study. They were further advised that they were free to opt not to complete the questionnaires if they wanted to. Every information gathered was kept strictly confidential. Only the principal researcher and assistant had access to the information.

3.9 Challenges During Data Collection and Strategies Used to Overcome

Challenge	**Overcoming Strategy**
Changing of study site by local ethical cause delay in data collection.	1. A repeat proposal was drafted promptly and resubmitted to deputy chairperson. Then an executive review and approval (before the next routine ethical committee meeting) was requested and was granted.
Provincial cooperation.	1. An official letter will be written to the Office of the Provincial Health Advisor (PHA) and permission was official granted. 2. Through established relationships, a dialogue was established with the Provincial Disease Control Officer to accompany the researcher during health facility visits for data collection and was actually done. When health facility staff saw their boss with the research team, they easily complied without much hesitation.

Transport and fuel.	1. A letter was written by the Executive Manager for Public Health at Ministry of Health requesting for vehicle. Sure enough, a good trooper was allocated with an experienced driver for data collection. 2. An NGO, Rotarians Against Malaria assisted with fuel throughout the study.
Staff payment as funds provided by TICA for data collection was insufficient.	1. A formal request was made at the Ministry of Health through the Office of the Executive Manager of Public Health. The response was positive and staff involved in the study were sorted satisfactorily.

CHAPTER 4

RESULTS

This study was designed to investigate factors (socioeconomic, individual, environmental) that directly or indirectly influence management of severe malaria among health workers, and also the current practice of health workers with regards to management of severe malaria. The study was conducted at selected health facilities within Central Province of Papua New Guinea. Data collection of the study occurred in May 2018. All results were processed using the software SPSS version 22.0, subject to College of Public Health Sciences, Chulalongkorn University, Bangkok, Thailand.

The calculated sample size was 142. Adding 10% to make up for losses gave a total of 156. However, the researcher settled for 142 participants successfully completed the self-administered questionnaires. Results are presented in two parts: descriptive statistics and inferential (analytical) statistics. Descriptive statistics primarily describes all independent and dependent variables in terms of mean, frequency and percentage. For inferential statistics, chi-square and Fisher exact where applicable were used for bivariate analyses, and binary logistics regression was used for multivariate analysis.

Internal consistency of the items was all checked using Cronbach's alpha coefficient. For knowledge the reading was taken as Kuder-Richardson 20 test (KR-20) and the score was 0.712. Items of scale constructs (attitude and perceptions) were taken as Cronbach's alpha, and the score was 0.7 (0.67). The IOC score for internal validity was 0.85.

After data collection, the Cronbach's alpha for attitudes was 0.68, and for perceptions was 0.70.

4.1 Descriptive Analysis

Descriptive analysis describes all items in terms of mean, frequency, percentage and cumulative percentage. Items described fall under the following constructs:

Socioeconomic characteristics, knowledge level, attitude to clinical practice, attitude to responsiveness, perceived susceptibility, perceived severity, perceived barriers, perceived benefits, perceived self-efficacy, cues to practice and practice. Practice is divided into four parts, (overall practice, diagnostic practice, treatment practice and follow-up), and each would have binary outcomes (compliant and non-compliant) after multivariate analysis.

4.1.1 Sociodemographic and Economic Characteristics

Sociodemographic and economic characteristics included in the study were: sex, age, marital status, religion, church service attendance information, social roles / positions, profession, working experience and income. Table 6 shows all sociodemographic and economic characteristics. Sixty percent of the participants were females. The mean age of the participants was 45 years. More than half (57.5%) of the participants were within the age group of 36 – 50 years, followed by those beyond 50 years of age. The quantity of younger (20 – 35 years) workforce was the least with 12.7%. None of the participants were below the age of 20 years.

More than eighty percent of the participants were married and living with their spouses and family. Being widowed and never married were equally least (4.2% each). Those widowed were noted to be all females above 50 years of age. A total of 28 (19.7%) participants were single, out of which 22 (22/28, 78.6%) were female and 6 (6/28, 21.4%) were male.

One hundred percent of the participants were Christians. However, only 63% regularly attended church services. Almost half (43.7%) of the participants held some sort of social positions apart from being a fulltime health worker.

Majority (62.0%) of the health workers of this largely rural province were CHWs. Two medical officers; the other was a female intern medical officer doing rural attachment in one of the health centres and the other was also a young female medical officer practising in a remote Catholic church agency health facility which also hosts a CHW training college.

More than half (55%) of the participants had more than 20 years' work experience. The oldest was one participant having 39 years work experience (not shown in the table as it comes under >20 years work experience group).

Close to half of the participants (46.5%) earned fortnightly income between K500 - K1000. Almost 20% earned less than K500 per fortnight.

Table 6: Sociodemographic and Economic Characteristics of Participants (n = 142)

Variable	Frequency	Percentage	Cumulative percentage
Sex			
Male	58	40.8	40.8
Female	84	59.2	100.0
Age group in years[a]			
<20	0	0.0	0.0
20 – 35	18	12.7	12.7
36 – 50	82	57.7	70.4
>50	42	29.6	100.0
Marital status			
Married	116	81.7	81.7
Never married	6	4.2	85.9
Divorced / Separated	14	9.9	95.8
Widowed	6	4.2	100.0
.			
Religion			
Christianity	142	100.0	100.0
Jehovah Witness	0	0.0	100.0
Mormonism	0	0.0	100.0
Islam	0	0.0	100.0
Church service attendance			
No	52	36.6	36.6
Yes	90	63.4	100.0
Social roles / positions			
No	80	56.3	56.3
Yes	62	43.7	100.0
Professions			
Medical officer	2	1.4	1.4
HEO	8	5.6	7.0
Nursing officer	44	31.0	38.0
CHW	88	62.0	100.0
Work experience in years[b]			
<10	21	14.8	14.8
10 – 20	42	29.6	44.4
>20	79	55.6	100.0
Income (salary) per fortnight			
Below K500	26	18.3	18.3
K500 – K1000	66	46.5	64.8
Above K1000	50	35.2	100.0

a = age: mean = 45.00; min.= 24 years max.= 61 years

b = work experience: median 23.00; mode 25.00; min.=0.5 years max.= 39 years

4.1.2 Knowledge

Table 7 shows that 67% of the participants were able to identify the correct definition of severe malaria from the choices provided, however, only 26% were able to identify the correct clinical features. Eighty-five percent (85%) of the participants knew requirements needed to obtained a reliable microscopy result, and 71% confirmed that RDT can be used to diagnose severe malaria. Ninety-four percent of the participants knew that an oral treatment was recommended following parenteral treatment, but only 35% knew the correct oral treatment drug (AL).

With treatment of severe malaria in pregnancy, artesunate and quinine are both recommended, hence, all the participants seemed to have gotten a tick for this item as shown in Table 7.

Table 7: Knowledge Regarding Severe Malaria (n = 142)

Variable	Correct n (%)	Incorrect n (%)	Total n (%)
What is severe malaria	95 (66.9)	47 (33.1)	142 (100)
*Clinical features of SM	38 (26.7)	104 (73.3)	142 (100)
Can RDT diagnosis of SM	101 (71.1)	41 (28.9)	142 (100)
RDT reading time	70 (49.2)	72 (50.7)	142 (100)
Gold standard of malaria diagnosis	74 (52.1)	68 (47.9)	142 (100)
Requirements for malaria microscopy	120 (84.5)	22 (15.5)	142 (100)
Neither RDT nor microscopy is available	119 (83.8)	23 (16.2)	142 (100)
First-line treatment of SM in general popn.	64 (45.1)	78 (54.9)	142 (100)
First-line treatment of SM in preg. women	142 (100.0)	0 (0.0)	142 (100)
Is second-line treatment of SM available	118 (83.1)	24 (16.9)	142 (100)
What is the second-line drug	76 (53.5)	66 (46.5)	142 (100)
Oral treatment after parenteral treatment	134 (94.4)	8 (5.6)	142 (100)
Oral treatment drug	50 (35.2)	92 (64.8)	142 (100)
AL use in pregnancy	61 (43.0)	81 (57.0)	142 (100)

*The item on clinical features of severe malaria was separately described as shown in Table 8. Fifty-eight percent of participants indicated ‘coma’ to be the predominant or rather, only sign of severe malaria. A quarter had the correct knowledge about clinical

features of severe malaria. Over 10% disagreed with all three options provided; coma, hypoglycaemia and respiratory distress. None of the participants knew that severe malaria patients could present with respiratory distress. In summary, three quarters of the participants were not well versed with the clinical features.

Table 8: Breakdown of Clinical Features of Severe Malaria (n = 142)

Clinical feature	Frequency	Percentage	Cumulative percentage
Coma	82	57.7	57.7
Hypoglycaemia	8	5.6	63.4
Respiratory distress	0	0.0	0.0
None of the above	16	11.3	74.6
All of the above	36	25.4	100.0

Knowledge was categorised into three groups as shown in Table 9: low, moderate and high. Just above 10% of the participants had good knowledge on severe malaria. More than half (63.4%) of the participants had poor knowledge.

Table 9: Categories of Knowledge on Severe Malaria

Variable	Frequency	Percentage	Cumulative percentage
Knowledge			
Poor (<60%)	90	63.4	63.4
Moderate (60 – 80%)	36	25.4	88.7
Good (>80%)	16	11.3	100.0

4.1.3 Attitudes

Attitude was divided into attitude towards clinical practice and attitude towards responsiveness (non-health needs of the patient). The options from participants were scaled by participants on a four-point Likert scale with the options strongly agree, agree, disagree and strongly disagree. No neutral option was provided. Nevertheless,

statistically a neutral category was created for attitudes (only) which fell between the lower and upper limits of the standard deviation.

Table 10 shows details of attitude to clinical practice. One hundred percent of the participants agreed that guidelines were important in the management of severe malaria and 98.6% concurred that guidelines do standardise practice regarding management of severe malaria. There was nil strong disagreement on the three positive statements on attitude to clinical practice. Nevertheless, 67% of the participants found the current guidelines to be ambiguous. Close to half (43.8%) of the participants preferred sticking to their routine habits than conforming to guidelines.

Table 10: Attitude to Clinical Practice (n = 142)

	Frequency (Percentage)			
Statement	Strongly agree	Agree	Disagree	Strongly disagree
The current practice guidelines regarding severe are confusing and inconvenient. [n]	30 (21.3)	64 (45.3)	40 (28.2)	7 (5.2)
In management of severe malaria, practice guidelines are important.	102 (71.8)	40 (28.2)	0 (0.0)	0 (0.0)
The current practice guidelines regarding severe malaria are difficult to apply and adapt to my specific practice. [n]	20 (14.2)	39 (27.5)	70 (49.4)	14 (9.9)
The current practice guidelines regarding severe malaria improve patient outcomes.	48 (33.8)	82 (57.7)	12 (8.5)	0 (0.0)
Generally, I would prefer to continue my routines and habits rather than to change based on practice guidelines. [n]	16 (11.3)	46 (32.4)	56 (39.4)	24 (16.9)
Guidelines help to standardise care and assure that patients are treated in a consistent way.	64 (45.1)	76 (53.5)	2 (1.4)	0 (0.0)
I don't have the time to stay informed about available guidelines on practice regarding severe malaria. [n]	2 (1.4)	32 (22.6)	78 (54.9)	30 (21.1)

[n] = negative statement requiring reverse scoring Mean score = 20.7 SD = ±2.4

Attitude to clinical practice was put into three groups demarcated by standard deviations on either side as shown in Table 11. Eighteen percent of the participants had a negative attitude to clinical practice regarding severe malaria, while 11% had a positive attitude. The remaining fell within the neutral category.

Table 11: Categories of Attitude to Clinical Practice (n = 142)

Variable	Frequency	Percentage	Cumulative percentage
Attitude towards clinical practice			
Negative (score < 18.1)	26	18.3	18.3
Neutral (18.1 ≥ score ≤ 23.1)	100	70.4	88.7
Positive (score >23.1)	16	11.3	100.0

Mean score = 20.7; SD = 2.4

Table 12 shows responses to items on attitude to responsiveness (non-health needs). More than 85% perceived that basic amenities were worthwhile in-patient management.

Table 12:Attitude to Responsiveness (n = 142)

	Frequency (Percentage)			
Statement	Strongly agree	Agree	Disagree	Strongly disagree
When managing severe malaria patients, it is not important to consider courtesy and sensitivity to potentially embarrassing moments because it is a waste of time. [n]	6 (4.2)	26 (18.3)	84 (59.2)	26 (18.3)
Patients or relatives should be allowed to give their views towards what interventions they receive and what they do not receive.	24 (16.9)	72 (50.7)	44 (31.0)	2 (1.4)
It is good practice to allow individuals to have the right to preserve confidentiality of their personal health information from health workers.	42 (29.6)	58 (40.8)	28 (19.7)	14 (9.9)
Very sick patients should not be kept waiting for longer periods at the health facility unnecessarily.	88 (62.0)	36 (25.4)	13 (9.3)	6 (4.2)
Basic amenities, such as clean waiting rooms or adequate beds and food in health facilities are important aspects of care that are often highly valued by the population.	64 (45.1)	58 (40.8)	18 (12.7)	2 (1.4)
It is a waste of time for clinicians to contribute to social support. [n]	2 (1.4)	12 (8.5)	96 (67.6)	32 (22.5)
It is good to allow for patients / relatives to select who or which facility they wish to go for healthcare.	26 (18.3)	68 (47.8)	36 (25.4)	12 (8.5)

[n] = negative statement requiring reverse scoring Mean score = 20.5 SD = ±2.5

Attitude to responsiveness was also put into three groups demarcated by the standard deviations on either side as shown in Table 13. Negative and positive attitudes to responsiveness shared approximately a quarter each of the participants. The remaining half had fell within the neutral category.

Table 13: Summary of Attitude to Responsiveness

Variable	Frequency	Percentage	Cumulative percentage
Attitude towards responsiveness			
Negative (score < 18.0)	32	22.5	22.5
Neutral (18.0 ≥ score ≤ 23.0)	80	56.3	78.9
Positive (score >23.0)	30	21.2	100.0

Mean score = 20.5 SD = 2.5

4.1.4 Perceptions

Table 14 shows details items and responses to perceived susceptibility from the study. Participants were split into halves in their opinions on wheather the population from the highlands of PNG are at higher risk of developing severe malaria or not. On the same token, the participants were also equally divided on their perception on wheather every Papua New Guinean has partial immunity to malaria. More than >40% had no strong perceptions.

Table 14: Perceived Susceptibility of Population to Severe Malaria

	Frequency (Percentage)			
Statement	Strongly agree	Agree	Disagree	Strongly disagree
People from highlands are at higher risk of being affected by severe malaria than people from lowlands.	30 (21.1)	50 (35.2)	46 (32.4)	16 (11.3)
Children will always get severe malaria if they are infected with malaria even if they are treated prompt. [n]	12 (8.5)	52 (36.7)	68 (47.9)	14 (9.9)
Pregnant women are more likely to be affected by severe malaria than non-pregnant women.	22 (15.5)	62 (43.7)	50 (35.2)	8 (5.6)
Every PNGan has partial immunity, Thus, reduced chances of developing severe malaria. [n]	6 (4.2)	66 (46.5)	60 (42.3)	4 (7.0)
Europeans coming into PNG have higher chances of dying from severe malaria.	20 (14.1)	66 (46.5)	46 (32.4)	10 (7.0)

[n] = negative statement requiring reverse scoring Mean score = 13.2

Perceived susceptibility was grouped as negative or positive perception demarcated by the mean. Majority of the participants (61%) had a higher perception of the populations susceptible to severe malaria as shown in Table 15.

Table 15: Summary of Perceived Susceptibility (n=142)

Variable	**Frequency**	**Percentage**	**Cumulative percentage**
Perceived susceptibility			
Low (score < 13.2)	55	38.7	38.7
High (score ≥ 13.2)	87	61.3	100.0

Mean score = 13.2

Table 16 shows that 97% of the participants perceived that severe malaria was a very serious condition. About 77% of the participants perceived that the risk to die from severe malaria in adults and children are the same.

Table 16: Perceived Severity of Participants to Severe Malaria (n=142)

	Frequency (Percentage)			
Statement	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
Severe malaria is not a very serious condition. ¤	0 (0.0)	4 (2.8)	66 (46.5)	72 (50.7)
Severe malaria patients can sometimes get better without treatment. ¤	10 (7.0)	12 (8.4)	60 (42.3)	62 (43.7)
Complications of severe malaria are dangerous and can result in death.	98 (69.4)	38 (26.8)	6 (4.2)	0 (0.0)
Risk of death from severe malaria in children and adults are the same. ¤	34 (23.9)	74 (52.8)	30 (21.1)	4 (2.8)
All patients with severe malaria should be admitted or referred.	74 (52.1)	58 (40.9)	8 (5.6)	2 (1.4)

¤ = negative statement requiring reverse scoring Mean score = 15.9

Perceived severity was grouped as low or high using mean score as cut off. More than half (54%) had a high perceived severity for severe malaria as summarised in Table 17 below.

Table 17: Summary of Perceived Severity (n=142)

Variable	**Frequency**	**Percentage**	**Cumulative percentage**
Perceived severity			
Low (score < 15.9)	62	43.7	43.7
High (score ≥ 15.9)	80	56.3	100.0

Mean score = 15.9

When it came to perceived barriers, 32% of the participants viewed RDT results as being very unreliable for diagnosing severe malaria. More than 80% believed that the current treatments for severe malaria are effective, and also believed that severe malaria should not be sent home if there was not RDT or drugs available at a health facility (Table 18).

Table 18: Perceived Barriers of Participants to Practice Regarding Severe Malaria (n=142)

	Percentage			
Statement	Strongly agree	Agree	Disagree	Strongly disagree
RDT results are very unreliable to diagnose severe malaria[n].	8 (5.6)	38 (26.8)	82 (57.7)	14 (9.9)
If there is no microscopy to confirm results, RDT should not be used[n].	8 (5.6)	12 (8.5)	82 (57.7)	40 (28.2)
Currently recommended first-line drugs antimalarial drugs (artemether & artesunate) are not very effective to treat severe malaria[n].	8 (5.6)	18 (12.7)	94 (66.2)	22 (15.5)
Severe malaria patients do not need prompt attention if there are no drugs to treat them[n].	6 (4.2)	8 (5.6)	78 (54.9)	52 (36.6)
Severe malaria patients should be sent home if there are no RDT or drugs at the health facility[n].	6 (4.2)	6 (4.2)	64 (45.1)	66 (46.5)

[n] = negative statement requiring reverse scoring Mean score = 15.3

The items of perceived barriers were grouped as low or high using the mean score as cut off as shown in Table 19. Majority of the participants (59%) had low perceived barriers to practice.

Table 19: Summary of Perceived Barriers

Variable	Frequency	Percentage	Cumulative percentage
Perceived barrier			
Low (score < 15.3)	84	59.2	59.2
High (score ≥ 15.3)	58	40.8	100.0

Mean score = 15.3

In terms of perceived benefit, more than 60% of the participants anticipated some form of benefits in return. Forty percent of the participants preferred to safeguarding their reputation in the community more than conforming to guidelines as shown in Table 20.

Table 20: Perceived Benefits from Participants (n=142)

Statement	Frequency (Percentage)			
	Strongly agree	Agree	Disagree	Strongly disagree
Health workers who perform well in management of severe malaria should be rewarded with bonus.	24 (16.9)	70 (49.3)	44 (31.0)	4 (2.8)
Health workers who perform well in management of severe malaria do not need any more training [n].	4 (2.8)	8 (5.6)	96 (67.7)	34 (23.9)
Health workers who perform well important illnesses such as severe malaria should be appraised for pay increase.	14 (9.9)	54 (38.0)	60 (42.3)	14 (9.9)
Health workers should safeguard their reputation more than complying to recommended guidelines [n].	12 (8.5)	42 (29.6)	66 (46.5)	22 (15.5)
When there is good patient education, the community thinks that the health worker is good.	20 (14.1)	114 (80.3)	6 (4.2)	2 (1.4)

[n] = negative statement requiring reverse scoring Mean score = 14.2

Perceived benefits were grouped as low or high using the mean score as cut off. Majority of the participants (60%) had a high perception for benefits as shown in Table 21.

Table 21: Summary of Perceived Benefits (n=142)

Variable	Frequency	Percentage	Cumulative percentage
Perceived benefit			
Low (score < 14.2)	56	39.4	39.4
High (score ≥ 14.2)	86	60.6	100.0

Mean score = 14.2

Table 22 shows responses to items on perceived self-efficacy. More than 70% perceived that they can distinguish clinical features of severe malaria from other illness and more than 90% perceived that they can predict outcomes.

Table 22: Perceived Self-efficacy of Participants to Practice Regarding Severe Malaria (n=142)

	Percentage			
Statement	Strongly agree	Agree	Disagree	Strongly disagree
I believe that I can distinguish the clinical features of severe malaria from other illnesses. [n]	32 (22.6)	82 (57.7)	24 (16.9)	4 (2.8)
I know how to perform a malaria RDT correctly.	54 (38.1)	80 (56.3)	6 (4.2)	2 (1.4)
I know how to implement the national treatment guidelines on severe malaria sufficiently enough.	24 (16.9)	92 (64.8)	24 (16.9)	2 (1.4)
I believe that I can overcome barriers to severe malaria cases based on national treatment guidelines.	18 (12.7)	100 (70.4)	20 (14.1)	4 (2.8)
I am sure about how to predict outcomes of clinical care of a patient with severe malaria. [n]	26 (18.3)	102 (71.9)	10 (7.0)	4 (2.8)

[n] = negative statement requiring reverse scoring Mean score = 15.2

Perceived self-efficacy was also grouped as low or high demarcated by the mean score. Table 23 summarises that 65% had a low self-efficacy of practice regarding severe malaria, while 35% had perceived self-efficacy which was truly positive for practice regarding severe malaria.

Table 23: Summary of Self-efficacy (n=142)

Variable	**Frequency**	**Percentage**	**Cumulative percentage**
Perceived self-efficacy			
Low (score < 15.2)	92	64.8	64.8
High (score ≥ 15.2)	50	35.2	100.0

Mean score = 15.2

4.1.5 Cues to Practice

Cues assessed in this study ranged from availability of diagnostic and treatment consumables to data feedback and supervision. Less than 20% had access to functional microscopy or a training in the last six months. Table 24 shows the entire frequency and percentage of exposure of the participants to different cues.

Table 24: Cues to Practice (n=142)

Variable	Yes n (%)	No n (%)	Total n (%)
Training in last 6 months	26 (18.3)	116 (81.7)	142 (100)
Functional microscopy	20 (14.1)	122 (85.9)	142 (100)
RDT availability	112 (78.9)	30 (21.1)	142 (100)
Access to treatment policy	134 (94.4)	8 (5.6)	142 (100)
Availability of artemether / artesunate	82 (57.7)	60 (42.3)	142 (100)
Supervision	62 (43.7)	80 (56.3)	142 (100)
Data sharing / feedback	80 (56.3)	62 (43.7)	142 (100)

Mean score = 3.4

Cues to practice were divided into two groups as shown in Table 25, using the mean as cut-off. Close to 60% of the participants were exposed to favourable cues.

Table 25: Summary of Cues

Variable	Frequency	Percentage	Cumulative percentage
Cues to practice			
Unfavourable (score < 3.4)	58	40.8	40.8
Favourable (score ≥ 3.4)	84	59.2	100.0

Mean score = 3.4

4.1.6 Practice

Items used to evaluate current practice regarding severe malaria covered diagnosis, treatment and follow up. During analysis, items on diagnosis, treatment and follow up were put together to compute data for overall practice. Items corresponding to each component were also computed independently. Table 26 shows the frequency and percentage of each item among the participants. More than 90% did utilise the treatment policy. More than 80% admitted to giving stat doses of intramuscular artemether injection.

Table 26: Overall Practice Regarding Severe Malaria (n=142)

Variable	Correct n (%)	Incorrect n (%)	Total n (%)
Practice of diagnosing SM	126 (88.7)	16 (11.3)	142 (100)
RDT performance	126 (88.7)	16 (11.3)	142 (100)
Microscopy utilisation (if available)	16 (11.3)	126 (88.7)	142 (100)
Utilisation of treatment policy	132 (93.0)	10 (7.0)	142 (100)
Administration of artesunate injection	86 (60.6)	56 (39.4)	142 (100)
Administration of artesunate suppository	44 (31.0)	98 (69.0)	142 (100)
Administration of artemether inj. stat dose	114 (80.3)	28 (19.32)	142 (100)
Administration of AL after parenteral Rx	102 (71.8)	40 (28.2)	142 (100)
Advise patients to return for follow up	102 (71.8)	40 (28.2)	142 (100)
Reason for follow up	8 (5.6)	134 (94.4)	142 (100)

Mean score = 6.1

Table 27 shows that almost 58% percent had poor compliance to national guidelines in terms of their 'overall practice'.

Table 27: Summary of Overall Practice (n=142)

Variable	Frequency	Percentage	Cumulative percentage
Overall practice			
Poor (score < 6.1)	82	57.7	57.7
Good (score ≥ 6.1)	60	42.3	100.0

Mean score = 6.1

The scores for items related to diagnostic, treatment and follow up were also independently computed and dichotomised into poor and good practice, demarcated by the mean as shown in the following tables. Table 28 shows that more than half (51.4%) of the participants had a poor level of diagnostic practice. On the other end, around similar proportion (53.5%) of the participants complied with national guidelines in terms of treatment of severe malaria as shown in Table 29.

Table 28: Summary of Diagnostic Practice (n=142)

Variable	Frequency	Percentage	Cumulative percentage
Diagnostic practice			
Poor (score < 2.4)	73	51.4	51.4
Good (score ≥ 2.4)	69	48.6	100.0

Mean score = 2.4

Table 29: Summary of Treatment Practice (n=142)

Variable	Frequency	Percentage	Cumulative percentage
Treatment practice			
Poor (score < 3.4)	66	46.5	46.5
Good (score ≥ 3.4)	76	53.5	100.0

Mean score = 3.4

Follow up comprised of the last two items of Table 26, and the summary of the scores are shown below in Table 30. Seventy-two percent of the participants would advise discharged patients to come for follow. However, only 8% would follow up patients for follow up microscopy, which is the recommended practice.

Table 30: Summary of Follow up (n=142)

Variable	Frequency	Percentage	Cumulative percentage
Follow up			
Poor (score ≥ 0.8)	38	26.8	26.8
Good (score ≥ 0.8)	104	73.2	100.0

Mean score = 0.8

4.2 Inferential Statistics

Inferential statistics was used to assess any association between the independent and dependent variables. Bivariate analysis was done using Chi-square. Fisher exact test was considered where expected cell counts were less than 5. Multivariate analysis was done using binary logistic regression for variables whose p-values were ≤ 0.2 in the bivariate analysis and for variables whose p-values were > 0.2 but demonstrated significance in other studies.

4.2.1 Bivariate Analysis

Bivariate analysis was done between all independent variables and each of the four components of dependent variable – overall practice, diagnosis, treatment and follow up.

Table 31 shows that socioeconomic characteristics that were significant (P < 0.05) were sex, social roles, and work experience. No statistics for religion was computed because one hundred percent of the participants were Christians.

Table 31: Association of Sociodemographic and Economic Factors with Overall Practice (n=142)

Factors	Poor practice n (%)	Good practice n (%)	X^2	P-value
Sex				
Male	28 (34.1)	30 (51.7)	3.604	***0.042**
Female	54 (64.3)	30 (35.7)		
Age group in years				
<20	0 (0.0)	0 (0.0)	1.446	0.485
20 – 35	12 (66.7)	6 (33.3)		
36 – 50	44 (53.7)	38 (46.3)		
>50	26 (61.9)	16 (38.1)		
Marital status				
Married	66 (56.9)	50 (43.1)	0.188	0.665
Single	16 (61.5)	10 (38.5)		
Religion				
Christianity	82 (57.7)	60 (42.8)	No statistic computed	
Jehovah Witness	0 (0.0)	0 (0.0)		
Mormonism	0 (0.0)	0 (0.0)		
Islam	0 (0.0)	0 (0.0)		
Church service attendance				
No	28 (34.1)	24 (65.9)	0.512	0.474
Yes	54 (60)	36 (40)		
Social roles / positions				
No	52 (65.0)	28 (35.0)	3.951	***0.047**
Yes	30 (46.9)	32 (53.1)		
Professions				
MO / HEO	6 (60.0)	4 (40.0)	1.037#	0.636
Nursing officer	28 (63.6)	16 (36.4)		
CHW	48 (54.5)	40 (45.5)		
Work experience in years				
<10	14 (66.7)	7 (33.3)	11.341	***0.003**
10 – 20	32 (76.2)	10 (23.8)		
>20	36 (45.6)	43 (54.4)		
Income (salary) per fortnight				
Below K500	14 (53.8)	12 (46.2)	0.446	0.800
K500 – K1000	40 (60.6)	26 (39.4)		
Above K1000	28 (56.0)	22 (44.0)		

= Fisher exact test

Table 32 shows that there was statistically significant association between knowledge (p=0.003) and attitude to responsiveness (p=0.016) with overall practice regarding severe malaria.

Table 32: Association of Knowledge and Attitudes with Overall Practice (n=142)

Factors	Poor practice n (%)	Good practice n (%)	X^2	P-value
Knowledge				
Low	60 (66.7)	30 (33.3)	11.877	***0.003**
Moderate	12 (33.3)	24 (66.7)		
High	10 (62.5)	6 (37.5)		
Attitude towards clinical practice				
Discouraging	16 (61.5)	10 (38.5)	2.681	0.262
Neutral	54 (54.0)	46 (46.0)		
Encouraging	12 (66.7)	4 (33.3)		
Attitude towards responsiveness				
Discouraging	24 (75.0)	8 (25.0)	8.325	***0.016**
Neutral	38 (47.5)	42 (52.5)		
Encouraging	20 (66.7)	10 (33.3)		

Table 33 shows bivariate outcomes for association of perception and cues with overall practice. Perceived susceptibility and perceived barrier were statistically not associated with overall practice regarding severe malaria, with p=0.756 and p=0.389 respectively. The other constructs of perception and cues were all significantly associated with overall practice.

Table 33: Association of Perception and Cues with Overall Practice (n=142)

Factors	Poor practice n (%)	Good practice n (%)	X^2	P-value
Perceived susceptibility				
Negative	54 (58.7)	38 (41.3)	0.096	0.756
Positive	28 (56.0)	22 (44.0)		
Perceived severity				
Negative	28 (45.2)	34 (54.8)	7.144	***0.008**
Positive	54 (67.5)	26 (32.5)		
Perceived barrier				
Negative	46 (54.8)	38 (42.5)	0.751	0.386
Positive	36 (62.1)	22 (37.9)		
Perceived benefit				
Negative	40 (46.5)	46 (53.5)	11.281	***0.001**
Positive	42 (75.0)	14 (25.0)		
Perceived self-efficacy				
Low	58 (64.4)	32 (35.6)	4.519	***0.034**
High	24 (46.2)	28 (53.8)		
Cues to practice				
Poor	40 (69.0)	18 (31.0)	5.058	***0.025**
Good	42 (50.0)	42 (50.0)		

With diagnostic practice regarding severe malaria, Table 34 shows that there is statistically significant association with the sociodemographic characteristics of age, marital status and type of health worker cadre (profession). Again, no statistics for religion were computed because every participant was a Christian.

Table 34: Association of Sociodemographic and Economic Factors with Diagnostic Practice (n=142)

Factors	Poor practice n (%)	Good practice n (%)	X^2	P-value
Sex				
Male	28 (48.3)	30 (51.7)	0.385	0.535
Female	45 (53.6)	39 (46.4)		
Age group in years				
<20	0 (0.0)	0 (0.0)	7.904	***0.019**
20 – 35	10 (55.6)	8 (44.4)		
36 – 50	49 (59.8)	33 (40.2)		
>50	14 (33.3)	28 (66.7)		
Marital status				
Married	61 (52.6)	55 (47.4)	0.352	0.556
Single	12 (46.2)	14 (53.8)		
Religion				
Christianity	73 (51.4)	69 (48.6)	No statistics	computed.
Jehovah Witness	0 (0.0)	0 (0.0)		
Mormonism	0 (0.0)	0 (0.0)		
Islam	0 (0.0)	0 (0.0)		
Church service attendance				
No	29 (55.8)	23 (44.2)	0.625	0.429
Yes	44 (48.9)	46 (51.1)		
Social roles / positions				
No	38 (47.5)	42 (52.5)	1.120	0.290
Yes	35 (56.5)	27 (43.5)		
Professions				
MO / HEO	10 (100.0)	0 (0.0)	1.037#	0.636#
Nursing officer	20 (45.5)	24 (54.5)		
CHW	43 (48.9)	45 (51.1)		
Work experience in years				
<10	13 (61.9)	8 (38.1)	1.187	0.552
10 – 20	20 (47.6)	22 (52.4)		
>20	40 (50.6)	39 (49.4)		
Income (salary) per fortnight				
Below K500	13 (50.0)	13 (50.0)	0.668	0.716
K500 – K1000	32 (48.5)	34 (51.5)		
Above K1000	28 (56.0)	22 (44.0)		

= Fisher exact test

The association of knowledge, attitudes to clinical practice and attitudes to responsiveness with overall practice had no statistical significance (Table 35).

Table 35: Association of Knowledge and Attitudes with Diagnostic Practice (n=142)

Factors	Poor practice n (%)	Good practice n (%)	X^2	P-value
Knowledge				
Low	51 (56.7)	39 (43.3)	5.492	0.064
Moderate	18 (50.0)	18 (50.0)		
High	4 (25.0)	12 (75.0)		
Attitude towards clinical practice				
Discouraging	13 (50.0)	13 (50.0)	0.888	0.641
Neutral	50 (50.0)	50 (50.0)		
Encouraging	10 (62.5)	6 (37.5)		
Attitude towards responsiveness				
Discouraging	14 (43.8)	18 (56.3)	1.772	0.412
Neutral	45 (56.3)	35 943.8)		
Encouraging	14 (46.7)	16 (53.3)		

Tables 36 shows that cues to practice was statistically associated with diagnostic practice regrading severe malaria (p=0.035). All constructs of perceptions had no statistical association with diagnostic practice.

Table 36: Association of Perceptions and Cues with Diagnostic Practice (n=142)

Factors	Poor practice n (%)	Good practice n (%)	X^2	P-value
Perceived susceptibility				
Negative	49 (53.3)	43 (46.7)	0.359	0.549
Positive	24 (48.0)	26 (52.0)		
Perceived severity				
Negative	31 (50.0)	31 (50.0)	0.087	0.768
Positive	42 (52.5)	38 (47.5)		
Perceived barrier				
Negative	41 (48.8)	43 (51.2)	0.556	0.456
Positive	32 (55.2)	26 (44.8)		
Perceived benefit				
Negative	43 (50.0)	43 (50.0)	0.173	0.677
Positive	30 (53.6)	26 (46.4)		
Perceived self-efficacy				
Low	51 (56.7)	39 (43.3)	2.720	0.099
High	22 (42.3)	30 (57.7)		
Cues to practice				
Poor	36 (62.1)	22 (37.9)	4.461	***0.035**
Good	37 (44.0)	47 (56.0)		

Sex and income were strongly associated with treatment practice with p-values 0.002 and 0.000 respectively (Table 37). No statistics were generated for religion as all participants were Christians.

Table 37: Sociodemographic and Economic Factors with Treatment Practice (n=142)

Factors	Poor practice n (%)	Good practice n (%)	X^2	P-value
Sex				
Male	18 (31.0)	40 (69.0)	9.402	***0.002**
Female	48 (57.1)	36 (42.9)		
Age group in years				
<20	0 (0.0)	0 (0.0)	2.013	0.365
20 – 35	10 (55.6)	8 (44.4)		
36 – 50	34 (41.5)	48 (58.5)		
>50	22 (52.4)	20 (47.6)		
Marital status				
Married	50 (43.1)	66 (56.9)	2.902	0.088
Single	12 (46.2)	14 (53.8)		
Religion				
Christianity	66 (46.5)	76 (53.5)	No statistics computed.	
Jehovah Witness	0 (0.0)	0 (0.0)		
Mormonism	0 (0.0)	0 (0.0)		
Islam	0 (0.0)	0 (0.0)		
Church service attendance				
No	22 (42.3)	30 (57.7)	0.574	0.449
Yes	44 (48.9)	46 (51.1)		
Social roles / positions				
No	42 (52.5)	38 (47.5)	2.670	0.102
Yes	24 (38.7)	38 (61.3)		
Professions				
MO / HEO	6 (60.0)	4 (40.0)	1.704#	0.427#
Nursing officer	24 (54.5)	20 (45.5)		
CHW	38 (43.2)	50 (56.8)		
Work experience in years				
<10	12 (57.1)	9 (42.9)	5.177	0.075
10 – 20	24 (57.1)	18 (42.9)		
>20	30 (38.0)	49 (62.0)		
Income (salary) per fortnight				
Below K500	14 (53.8)	12 (46.2)	16.019	***0.000**
K500 – K1000	40 (60.6)	26 (39.4)		
Above K1000	12 (24.0)	38 (76.0)		

* Fisher exact test

Table 38 shows that knowledge had a statistical association with treatment practice. Attitudes to clinical and responsiveness had no statistical relationship treatment practice.

Table 38: Association of Knowledge and Attitudes with Treatment Practice (n=142)

Factors	Poor practice n (%)	Good practice n (%)	X^2	P-value
Knowledge				
Low	50 (55.6)	40 (44.4)	8.560	***0.014**
Moderate	10 (27.8)	26 (72.2)		
High	6 (37.5)	10 (62.5)		
Attitude towards clinical practice				
Discouraging	14 (53.8)	12 (46.2)	1.095	0.578
Neutral	46 (46.0)	54 (54.0)		
Encouraging	6 (37.5)	10 (62.5)		
Attitude towards responsiveness				
Discouraging	18 (56.3)	14 (43.8)	1.738	0.419
Neutral	34 (42.5)	46 (57.5)		
Encouraging	14 (46.7)	16 (53.3)		

Table 39 shows that cues to practice and all perceptions, except perceived benefit, had no statistically significant association with treatment practice. Nevertheless, perceived self-efficacy was pursed for multivariate analysis as its p-value met the criteria (<0.2).

Table 39: Association of Perceptions and Cues with Treatment Practice (n=142)

Factors	Poor practice n (%)	Good practice n (%)	X^2	P-value
Perceived susceptibility				
Negative	46 (50.0)	46 (50.0)	1.302	0.254
Positive	20 (40.0)	30 (60.0)		
Perceived severity				
Negative	26 (41.9)	36 (58.1)	0.913	0.339
Positive	40 (50.0)	40 (50.0)		
Perceived barrier				
Negative	42 (50.0)	42 (50.0)	1.025	0.311
Positive	24 (41.4)	34 (58.6)		
Perceived benefit				
Negative	34 (39.5)	52 (60.5)	4.227	***0.040**
Positive	32 (57.1)	24 (42.9)		
Perceived self-efficacy				
Low	46 (51.1)	44 (48.9)	2.120	0.145
High	20 (38.5)	32 (61.5)		
Cues to practice				
Poor	30 (51.7)	28 (48.3)	1.084	0.298
Good	36 (42.9)	48 (57.1)		

Table 40 shows that sex (p=0.03), profession (p=0.037) and income (p=0.047) were all statistically associated with follow up.

Table 40: Association of Sociodemographic and Economic Factors with Follow up (n=142)

Factors	Poor practice n (%)	Good practice n (%)	X^2	P-value
Sex				
Male	22 (37.9)	36 (62.1)	4.648	**0.032**
Female	18 (21.4)	66 (78.6)		
Age group in years				
<20	0 (0.0)	0 (0.0)	1.370	0.504
20 – 35	6 (33.3)	12 (66.7)		
36 – 50	20 (24.4)	62 (75.6)		
>50	14 (33.3)	28 (66.7)		
Marital status				
Married	30 (25.9)	86 (74.1)	1.666	0.197
Single	10 (38.5)	16 (61.5)		
Religion				
Christianity	40 (28.2)	102 (71.8)	No statistics computed.	
Jehovah Witness	0 (0.0)	0 (0.0)		
Mormonism	0 (0.0)	0 (0.0)		
Islam	0 (0.0)	0 (0.0)		
Church service attendance				
No	18 (34.6)	34 (65.4)	1.685	0.195
Yes	22 (24.4)	68 (75.6)		
Social roles / positions				
No	24 (30.0)	56 (70.0)	0.304	0.582
Yes	16 (25.8)	46 (74.2)		
Professions				
MO / HEO	6 (60.0)	4 (40.0)	6.585#	***0.037**
Nursing officer	14 (31.8)	30 (68.2)		
CHW	20 (22.7)	68 (77.3)		
Work experience in years				
<10	6 (28.6)	15 (71.4)	0.587	0.746
10 – 20	10 (23.8)	32 (76.2)		
>20	24 (30.4)	55 (69.6)		
Income (salary) per fortnight				
Below K500	10 (38.5)	16 (61.5)	6.130	***0.047**
K500 – K1000	12 (18.2)	54 (81.8)		
Above K1000	18 (36.0)	32 (64.0)		

= Fisher exact reading

Table 41 shows that knowledge, attitude to clinical practice and attitudes and to responsiveness were all statistically associated with follow up.

Table 41: Association of Knowledge and Attitudes with Follow up (n=142)

Factors	Poor practice n (%)	Good practice n (%)	X^2	P-value
Knowledge				
Low	26 (28.9)	64 (71.1)	6.146	***0.046**
Moderate	6 (16.7)	30 (83.3)		
High	8 (50.0)	8 (50.0)		
Attitude towards clinical practice				
Negative	10 (38.5)	16 (61.5)	7.011	***0.030**
Neutral	22 (22.0)	78 (78.0)		
Positive	8 (50.0)	8 (50.0)		
Attitude towards responsiveness				
Negative	4 (12.5)	28 (87.5)	8.974	***0.011**
Neutral	22 (27.5)	58 (72.5)		
Positive	14 (46.7)	16 (53.3)		

Out of the five constructs of perception, perceived severity (p=0.005) and perceived barrier (p=0.032) were significantly associated with follow, as shown in Table 42. Perceived benefit was however considered for multivariate analysis as it had $p < 0.2$. Cues to practice were also associated with follow up (p=0.032).

Table 42: Association of Perceptions and Cues with Follow up (n=142)

Factors	Poor practice n (%)	Good practice n (%)	X^2	P-value
Perceived susceptibility				
Negative	24 (26.1)	16 (32.0)	0.560	0.454
Positive	68 (73.9)	34 (68.0)		
Perceived severity				
Negative	10 (16.1)	52 (83.9)	7.884	***0.005**
Positive	30 (37.5)	50 (62.5)		
Perceived barrier				
Negative	18 (21.4)	66 (78.6)	4.618	***0.032**
Positive	22 (37.9)	36 (62.1)		
Perceived benefit				
Negative	20 (23.3)	66 (76.7)	2.602	***0.107**
Positive	20 (35.7)	36 (64.3)		
Perceived self-efficacy				
Low	26 (28.9)	64 (71.1)	0.063	0.802
High	14 (26.9)	38 (73.1)		
Cues to practice				
Poor	22 (37.9)	36 (62.1)	4.618	***0.032**
Good	18 (21.4)	66 (78.6)		

4.3.2 Multivariate Analysis

Multivariate analysis was undertaken to see which independent variables were really associated with the dependent variable(s) without influence from covariates. As the outcomes were going to be dichotomous (compliant and non-compliant to guidelines), binary logistic regression was used. Independent variables entered into logistic regression were those which had $p<0.2$ and variables which were significant in other studies despite have $p>0.2$ in the current study.

Practice was divided into overall practice, diagnostic practice, treatment practice and follow up as also shown in descriptive and bivariate analyses.

Multivariate Analysis for Overall Practice

Independent variables entered into multivariate model for overall practice are as follows:

i. $p<0.2$ – no variable under this category was identified.

ii. $p<0.05$ - sex ($p=0.042$), social roles ($p=0.047$), work experience ($p=0.003$), knowledge ($p=0.003$), attitude to responsiveness ($p=0.016$), perceived severity ($p=0.008$), perceived benefit (0.001), perceived self-efficacy (0.034) and cues to practice (0.025).

iii. Independent variables that were significant in other studies - age, profession, attitude to clinical practice, perceived susceptibility, perceived barrier and cues to practice.

Table 43 shows results of multivariate analysis of overall practice performed using binary logistics regression at 95% CI. Significant observations were:

- Participants with high knowledge were 42.5 times more likely to comply with national guidelines in overall practice as compared to low knowledge.
- Participants with high perceived benefit were 6.2 times more likely to comply with guidelines in overall practice as compared with low perceived benefit.
- Participants with >20 years' experience were 0.18 times less likely to comply with overall practice as compared with <10 years' experience.

Table 43: Multivariate Analysis for Overall Practice Regarding Severe Malaria

Variables	B	Sig.	AOR	95% CI	
				Lower	Upper
Sex[a]	.485	.513	1.624	.380	6.947
Age group in years					
20 – 35[R]		.626			
36 – 50	2.890	.514	17.992	.003	15.647
>50	0.627	.415	1.872	.414	8.456
Social roles[b]	-0.490	.416	.613	.188	1.994
Profession					
MO/HEO[R]		.637			
Nursing officer	-.215	.752	.806	.212	3.062
CHW	-.361	.348	.697	.328	1.481
Work experience					
<10[R]		.085			
10 – 20	-2.785	.521	.062	.000	303.395
>20	**-1.712**	**.029**	**.181**	**.039**	**.836**
Knowledge					
Low[R]		.001			
Moderate	.246	.815	1.279	.164	9.966
High	**3.750**	**.001**	**42.531**	**4.239**	**426.739**
Clinical attitude					
Negative[R]		.197			
Neutral	-.554	.666	.575	.046	7.119
Positive	.755	.498	2.128	.240	18.869
Responsiveness attitude					
Negative[R]		.007			
Neutral	-.693	.483	.500	.072	3.465
Positive	1.637	.069	5.141	.881	29.991
Perceived susceptibility[c]	-1.113	.081	.328	.094	1.147
Perceived severity[d]	1.204	.091	3.335	.826	13.454
Perceived barrier[e]	1.450	.059	4.263	.945	19.232
Perceived benefit[f]	**1.833**	**.015**	**6.251**	**1.422**	**27.472**
Perceived self-efficacy[g]	-1.457	.095	.233	.042	1.288
Cues to practice[h]	-.515	.445	.597	.159	2.241

(R): Reference group

a): Male is the reference.

b): No social role is the reference.

c): Low perceived susceptibility is the reference.

d): Low perceived severity is the reference.

e): Low perceived barrier is the reference.

f): Low perceived benefit is the reference.

g): Low perceived self-efficacy is the reference.

h): Favourable cues is the reference.

Multivariate Analysis for Diagnostic Practice

Independent variables entered into multivariate model for diagnostic practice:

i. p<0.2 – knowledge (p=0.064).

ii. p<0.05 - age (p=0.019), cues to practice (p=0.035).

iii. Independent variables that were significant in other studies - sex, marital status, profession and perceived self-efficacy.

Table 44 shows multivariate results for diagnostic practice at 95% CI:

- Age group >50 years were 0.17 times less likely to comply to national guidelines in their diagnostic practice as compared to age group 20-35 years.
- Participants with moderate knowledge were 0.25 times less likely to comply with diagnostic practice as compared to low knowledge.

Table 44: Multivariate Analysis for Diagnostic Practice Regarding Severe Malaria

Variables	**B**	**Sig.**	**AOR**	**95% CI**	
				Lower	**Upper**
Sex[a]	.470	.272	1.601	.691	3.705
Age group in years					
20 – 35[R]		.002			
36 – 50	-.892	.261	.410	.086	1.944
>50	**-1.773**	**.001**	**.170**	**.062**	**.463**
Marital status[b]	-.629	.200	.533	.204	1.396
Profession					
MO/HEO[R]		.993			
Nursing officer	-21.878	.999	.000	.000	.000
CHW	.052	.908	.831	1.054	.433
Knowledge					
Low[R]		.082			
Moderate	**-1.367**	**.026**	**.255**	**.076**	**.360**
High	-1.099	.099	.333	.090	1.231
Perceived self-efficacy[c]	.500	.340	1.643	.591	4.605
Cues to practice[d]	-.817	.080	.442	.177	1.102

(R): Reference group

a): Male is the reference.

b): Married is the reference.

c): Low perceived self-efficacy is the reference.

d): Favourable cues is the reference.

Multivariate Analysis for Treatment Practice

Independent variables entered into multivariate model for treatment practice are as follows:

i. p<0.2 – marital status (p=0.088), social roles (p=0.102), work experience (p=0.075), and perceived self-efficacy (p=0.145).
ii. p<0.05 - sex (p=0.002income (0.000), knowledge (p=0.014), perceived benefit (p=0.040).
iii. Independent variables that were significant in other studies - cues to practice.

Table 45 shows results of multivariate analysis of treatment practice performed using binary logistics regression at 95% CI. Significant observations were as follows:

- Females participants were 2.28 times more likely to comply with national guidelines when treating severe malaria, as compared to their male counterparts.
- Participants earning >K500 per fortnight were 0.25 times less likely to comply with their treatment practice as compared to those receiving <K500 per fortnight.
- High perceived benefit was 2.5 times more likely to comply with treatment practice compared to low perceived benefit.

Table 45: Multivariate Analysis for Treatment Practice Regarding Severe Malaria

Variables	B	Sig.	AOR	95% CI	
				Lower	Upper
Sex[a]	**.824**	**.046**	**2.281**	**1.017**	**5.117**
Marital status[b]	.748	.093	2.112	.884	5.048
Social roles[c]	-.330	.453	.719	.304	1.702
Work experience					
<10[R]		.436			
10 – 20	-.339	.596	.713	.204	2.491
>20	-.594	.200	.552	.222	1.370
Income					
<K500[R]		.020			
K500 – K1000	**-1.245**	**.034**	**.288**	**.091**	**.908**
>K1000	**-1.241**	**.007**	**.289**	**.116**	**.717**
Knowledge					
Low[R]		.111			
Moderate	-.052	.941	.950	.239	3.772
High	.974	.204	2.649	.588	11.931
Perceived benefit[d]	**.927**	**.042**	**2.527**	**1.032**	**6.187**
Perceived self-efficacy[e]	-.217	.636	.805	.327	1.980
Cues to practice[f]	-.357	.298	.700	.357	1.371

(R): Reference group

a): Male is the reference.

b): Married is the reference.

c): No social role is the reference.

d): Low perceived benefit is the reference.

e): Low perceived self-efficacy is the reference.

f): Favourable cues is the reference.

Multivariate Analysis for Follow up Practice

i. $p<0.2$ – marital status ($p=0.197$), church service (0.195), perceived benefit ($p=0.107$).

ii. $p<0.05$ - sex ($p=0.032$), profession ($p=0.037$), income ($p=0.047$), knowledge ($p=0.046$), attitude to clinical practice ($p=0.030$), attitude to responsiveness ($p=0.011$), perceived severity (0.005), perceived barrier ($p=0.032$), and cues to practice ($p=0.032$).

iii. Independent variables that were significant in other studies – variables significant in other studies all named above already.

According to Table 46, significant observations were as follows:

- Participants living alone (single) were 6.3 times more likely to follow up discharged severe malaria patients compared to their married counterparts.
- Nursing officers were 0.15 times less likely to comply follow up compared to medical officers and HEOs.
- Participants with high knowledge were 17.4 times more likely to do follow up compared to low knowledge.
- Participants with positive attitude to responsiveness were 5.8 times more likely to follow up severe malaria patients.
- Participants exposed to unfavourable cues were 0.15 times less likely to follow up patients discharged severe malaria.

Table 46: Multivariate Analysis for Follow up Practice Regarding Severe Malaria

Variables	B	Sig.	AOR	95% CI	
				Lower	Upper
Sex[a]	-1.368	.056	.255	.063	1.033
Marital status[b]	**1.845**	**.012**	**6.325**	**1.491**	**26.840**
Church service[c]	-.546	.322	.579	.196	1.709
Profession					
MO/HEO[R]		.060			
Nursing officer	**-1.837**	**.039**	**.159**	**.028**	**.910**
CHW	-1.174	.089	.309	.080	1.196
Income					
<K500[R]		.049			
K500 – K1000	-.687	.367	.503	.113	2.242
>K1000	-1.157	.071	1.3179	.905	11.167
Knowledge					
Low[R]		.018			
Moderate	.215	.804	1.240	.226	6.818
High	**2.861**	**.013**	**17.487**	**1.845**	**165.677**
Clinical attitude					
Negative[R]		.105			
Neutral	.770	.453	2.160	.289	16.145
Positive	1.654	.074	5.226	.852	32.070
Responsiveness attitude					
Negative[R]		.058			
Neutral	1.252	.182	3.497	.556	21.991
Positive	**1.766**	**.017**	**5.846**	**1.370**	**24.943**
Perceived severity[d]	.500	.479	1.679	.400	7.049
Perceived barrier[e]	-.259	.709	.772	.198	3.004
Perceived benefit[f]	-.593	.384	.553	.145	2.102
Perceived self-efficacy[g]	-.098	.802	.907	.423	1.946
Cues to practice[h]	**-1.879**	**.005**	**.153**	**.041**	**.575**

(R): Reference group

a): Male is the reference.

b): Married is the reference.

c): No church service attendance is the reference.

d): Low perceived severity is the reference.

e): Low perceived barrier is the reference.

f): Low perceived benefit is the reference.

g): Low perceived self-efficacy is the reference.

h): Favourable cues is the reference.

CHAPTER 5

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

5.1.1 Sociodemographic and Economic Factors

In this study females comprised majority (59%) of the participants. This finding was consistent with the last PNG national health facilities survey conducted in 2016 where 54.9% were females [41]. According to the WHO Global Atlas of the Health Workforce 2006, females made up more than 90% of nurses in South – East Asian Region [118]. CHWs are not a uniform category, they include volunteers, auxiliaries and even nurses depending on respective health systems. In PNG nursing officers and CHWs are collectively referred to as nurses. Nurses make up 62 – 85% of the health workforce worldwide [118]. Given the fact that nursing officers and CHWs made up more than 93% of the current study population, it somewhat reflects the regional as well as global figures. The picture was apparent during the study period where female staff were noted to outnumber male staff in more than half of the health facilities covered.

The mean age of the participants was 45 years (± 8 years) which was reflective of the 2016 national health facilities survey which found 41 years ((± 1 year) [41]. The quantity of young workforce in the study was the least (12.7%). The rest were within middle age or approaching retirement age. The finding is similar to the national figures where aging health workforce is a significant concern, as mentioned in the National Health Plan 2011 – 2020 and adopted into the National Malaria Strategic Plan 2014 – 2020 [10]. The World Bank published an article in December 2015 stating that East Asia and Pacific is aging faster than any other region [119]. The finding in the current study is reflective of this happening. In addition, pull factors such as prospect of better working conditions or career development do force younger

workforce to urban health facilities. This is supported by a systemic review published in the *Journal of Public Health in Africa* in December 2016 [120].

In this study 56% of participants had work experience >20 years. The spread was wide, ranging from 6 months to 39 years and not normally distributed. Nevertheless, the mode was 25 years and the median was 23 years. This is not too distant from that mentioned in the last PNG national health facilities survey done in 2016 which states a mean clinical work experience of 18 years [41].

Majority (82%) of the participants were married at the time of the study. Marital status is an area that has not been investigated by the central health ministry of PNG, nevertheless, the finding is similar with a cross sectional study conducted among rural health workers in PNG in 2012 where married health workers comprised 81% of the study population [121]. Our finding is also supported by another cross-sectional study conducted in Kuwait in 2011 which surveyed 1553 primary health workers and found that 85% were married at the time of study [122].

The proportion of each health worker cadre in the current study is similar to the national figures covered in the health facility survey of 2016 [41]: CHWs in the current study were 62% while in the national survey was 68%; nursing officers in the current study were 31% while in the national survey was 25.8%; HEOs in the current study was 5.6% while in the national survey was 5.7% [41]. CHWs in PNG are professionally trained health workers who are specifically trained to serve in primary health facilities, or nursing aids in higher facilities. In PNG health system CHWs and nursing officers are collectively referred to as nurses for industrial reasons. CHWs do perform nursing officers' job when circumstances permit [121], for example, being alone in a remote facility. The proportion of each health worker cadre, especially doctors and nurses, in the current study was reflective of the 2012 report for Organisation for Economic Co-operation and Development (OECD) in collaboration with WHO on health workforce section which states that doctors are the lowest followed by nurses. This proportions are true for Asia Pacific as well as across the globe [123].

For data analysis, medical officers and HEOs were combined to help reduce skewed distribution because medical officers were just two and HEOs were eight. And also, it was observed that responses from the two medical officers and eight HEOs were similar. Both professions are degree courses studied over five and four years respectively. This organisation is supported by a cross-sectional study among health workers in lower health facilities in Uganda where prescribers (doctors and clinical officers) were put in one group and lower cadre in another group for analysis [72]. Clinical officers in Uganda are unique health professionals trained higher than nurses but below doctors to practice the full scope of medicine and provide routine care in general medicine in rural facilities or within a medical specialty outside nurses' scope [124]. Similarly, HEOs in PNG are trained above nurses and below doctors. They provide general medical care, including minor surgeries, and public health management at rural facilities.

One hundred percent of the participants were Christians. Papua New Guinea is predominantly a Christian country – according to the 2011 national census, 96% of the population are Christians [62]. This study agrees with the national figure. However, only 63% attended church services regularly.

According to World Bank 2017, PNG's inflation current rate is 4.7% and the gross domestic product (GDP) partial purchasing power (GDP) stands at 30.84 USD. It was disheartening to discover that close to 20% of participants were earning less than K500. Although K500 is more above the minimum wages of K240 as stated in *PNG Public Service General Orders 2016* [125], the cost of living is higher. According to *Numbeo (last updated June 2018),* essential expenditures, adjusted fortnightly (excluding rentals), of some common goods and services are as follows;

Food	– K29.40 (Asian type food)
Utilities	- K424.10 (flexible)
School fees	- K18.03
Clothes & Shoes	- K103.80
Rural vegetables	- K68.00
	K827.92

In view of our study being rural based, the listed goods were selected from a longer list of goods and services with respective prices. Considering the ever-increasing costs of goods and services, even a salary between K500 and K1000, as received by half the participants in this study, may not be sufficient. The injustice was that two of these participants had more than 10 years' experience, seven participants had more than 20 years' experience and another two participants had more than 30 years' work experience. There are anecdotal reports of health workers resorting to receiving illegitimate out-of-pocket payments from patients but a study is yet to quantify the extent. Disparities in salary observed in our study agreed with a qualitative survey done in 2011 which found that there were discrepancies in salaries among health workers in rural PNG where public health workers expressed dissatisfaction over salaries they receive [126]. The finding also coincided with a qualitative cross-sectional study from Indian in May 2017 which stated that nearly a million health workers forming the frontline of India's public health system were underpaid [127]. Some parts of the world also have similar issues. An investigation using empirical data in sub-Saharan Africa conducted in 2007 showed wide discrepancies in public health workers pays [128]. The pay issue may not be isolated to the current study and reasons vary from country to country. Possible hypotheses to consider for PNG are that workers are not filling their appraisals, or the workers are not being appraised, or fault with the payroll system. An investigation is required to define the cause.

5.1.2 Knowledge

It is a concern to note that more than half (63.4%) of the participants had poor knowledge regarding severe malaria. A quarter had moderate knowledge and just over 10% had good knowledge. In the 2016 national health facilities survey [41], the average AL score was 63.8% (moderate). In our study, 64.8% did not know that AL was recommended after parenteral treatment in severe malaria patients, although they knew how to administer the drug. No local studies assessing health workers' knowledge on severe malaria, especially injection drugs have not been done but our finding reveals that knowledge regarding treatment of severe malaria was a gap among the participants.

With regards to RDTs, the national survey of 2016 showed that health workers' knowledge mean score on RDT increased from 3.6 in 2010 to 4.4 (75.6%) in 2016 [41]. However, our study was not convinced by the quantity of participants that gave the correct RDT reading time – 49.2%. The difference could be because our study had limited items of RDT and also a smaller sample size. Nonetheless, these two different findings need reconfirmation from another study.

Our findings are not encouraging for a malaria endemic country like PNG. A contributing factor to the low knowledge on severe malaria could be due to the decline in malaria trends observed in the country (PNG) over the last 15 years as partly indicated by PNGIMR's NMCP Outcome & Impact Survey 2009-2014 [18], during which severe malaria fell to negligible levels (0.05%) according to PNG NHIS 2016 [19]. This could be compounded by lack of staff training as portrayed in our study. The last National Malaria Indicator Survey conducted from 2016-2017 showed that there was resurgence in certain provinces [129]. There is the likelihood that populations have lost immunity, which can happen after reduced exposure for 5 – 10 years, as supported by a mathematical modelling study published in *PLoS One* in 2009 [36], and are at higher risk of developing severe malaria.

Specific studies assessing health workers' knowledge on severe malaria are limited in the region and as well as other parts of the world. A cross-sectional study in Tanzania in 2011 confirmed that knowledge on severe malaria was low resulting in sub-optimal management [53].

5.1.3 Attitudes

Of the three categories of attitude to clinical practice (negative, neutral and positive), only 11% (least) of the participants had positive attitude to clinical practice while 18% had negative attitude, and the rest (71%) fell within the neutral category. The low positive attitude could reflect the (low) level of attention severe malaria gets, and the low knowledge among the participants. No national study on health workers attitude to practice regarding severe malaria is present at the moment for comparison.

The 2016 health facilities survey included items on uncomplicated malaria and prevention, and showed a more positive attitude [41] but that cannot be compared with the current study. A cross-sectional study from Tanzania in 2008 also showed a positive clinical attitude from health workers [77] but that study was also centred on uncomplicated malaria. A specific study to assess attitude to case management of severe malaria would be appropriate to add validity to the finding here.

Almost a quarter (20%) of the participants had a positive attitude to responsiveness. This was surprising and encouraging because usually responsiveness does not get much attention as does clinical practice. However, there are initiatives (standards and infection control) within PNG health systems which do promote elements of responsiveness, although without specifying the field. While no local study is available for comparison, the finding does reflect a WHO publication; *'People at the Centre of Health Care – Harmonizing mind and body, people and systems'* which generally states that responsiveness to patients is usually lacking in public health service in South East Asia and Western Pacific Regions [130]. The situation could be different in high income countries. A cross sectional study from England in 2017 found that physicians demonstrated a positive attitude to holistic patient approach after witnessing positive results from such approach [80]. The logic could be due to having a policy and enforcement mechanisms in place. As health workers gradually become aware of importance of non-health needs, while meeting health needs, they will appreciate the effect.

5.1.4 Perceptions

Perceived Susceptibility

Majority of the participants (61%) had a high perception of the population's susceptibility to severe malaria. This finding is expected in view of the study site being a malaria endemic province. No local studies assessing health workers' perception on the population's susceptibility to severe malaria have been done so far. However, with regard to malaria in general, a qualitative study done in Tanzania in 2008 showed a high perceived susceptibility among health workers in malaria endemic area [77].

Perceived Severity

More than half of the participants in this study had high perceived severity about severe malaria, which was expected and a good indication. There is no local study to compare our finding with, nonetheless, the finding agrees with a qualitative study from Nigeria in 2016 done among health workers of lower-level facilities in which one of the findings was; participants perceived that severe malaria was a serious condition and the effective artesunate injection should be administered promptly, while highlighting that training was needed [131].

Perceived Barriers

It was encouraging to note low perceived barriers (59.2%) among the participants, considering the fact that they serve in resource-limited and tough conditions. This could mean that health workers have accepted the resource-limited environments they work in, and so improvise in any way they can to treat patients rather than dwelling on barriers. Further studies are needed in this regard.

While there is no local study to make comparison, one of the main perceived impediments (barriers) over the years among health workers regarding malaria case management in general has been about health workers doubting RDTs. However, our finding shows otherwise, and agrees with the latest health facility survey of PNG conducted in 2016 [41]. The change to higher perception of RDT has been due to the gradual infiltration of information on benefits of RDT into the health workforce [41]. (Note that RDT performance score was low in this study despite the perception being high). This means health workers have come to believe in RDT but they performing and reading the result incorrectly. Similar trends in increased perception of RDT among health workers have been observed in other malaria endemic countries. A cross sectional survey from Tanzania conducted in 2013 showed that the testing rate had increased from 59% to 66%, and was hoped to increase further [82]. Another comparative cross sectional study between public and private health workers also from Nigeria conducted in 2016 showed that RDT use was 85.2% in public health facilities compared to 32.9% in private health facilities [83].

Perceived Benefits

More than 60% of the participants perceived that certain benefits should be accorded if they perform well in case management of severe malaria. There is no specific local study regarding health workers perceiving benefits from managing severe malaria. But in terms of general patient management, the finding is supported by a qualitative study done in PNG among rural health workers in 2012, where more than half of the participants expressed that they perceived better social benefits in terms of security, patient attitude and community support [132]. Incentives for some diseases' management are sometimes offered. For example, staff engaged in management of malnourished children in the wards are sent for trainings and also involve in nutrition surveys. The feasibility is there for it to happen for malaria or severe malaria.

Majority (60%) of the participants had low perceived self-efficacy regarding case management of severe malaria. Although there is no local study to compare the finding, the low prevalence of knowledge among the participants is one possible explanation. A survey conducted among physicians in Kentucky, USA, in 2012 found that acquisition of evidence (knowledge) increased self-efficacy [89]. Responses provided to two items - 'distinguishing clinical features of severe malaria from other causes' and 'predicting outcomes' – indicated that more than half of the participants had over-confidence in some aspects of severe malaria case management.

5.1.5 Cues to Practice

Close to 60% of the participants were exposed to favourable cues. However, zooming closer, availability of RDT, injectable antimalarials and accessibility to treatment guidelines were answered positively by 79%, 58% and 94% respectively. Supervision and data feedback did average contributions while 18.3% attended trainings in the past 6 months. The health facilities survey of 2016 had similar findings, where 41.0% of the staff surveyed had attended training on the malaria treatment guidelines [41]. The difference in training could be due to sample size difference. Microscopy was functional in 11% of the facilities which was within reach from the national figure (8%) according to the PNG national health facilities survey of 2016 [41]. Although the overall scores on cues was good, microscopy score was very low; the obvious

reason being that it was available on only 11% of the facilities covered in the study. Forty-two percent (42%) of the participants responded that injectable artemether / artesunate were not consistent. As our study was subjective (self-reported), this can be verified objectively. Some of our findings on cues are similar with studies from other countries. A cross-sectional study from Indian in 2017 hinted that non-training of primary health workers was a hindrance to health work [127]. Another cross-sectional study in Uganda confirmed that training on severe malaria among health workers was lacking [53].

5.1.6 Practice Regarding Severe Malaria

More than half of the participants portrayed poor overall and diagnostic practices, 57.7% and 51.4% respectively. Treatment practice was good (53.3%). Diagnosis and treatment contribute independently to the overall outcome of severe malaria patients. If one spectrum is deficient, the overall practice is affected and that is the likely instance here. In terms of overall practice, the findings cannot be compared to a previous PNG study on severe malaria as there is none. Even within the region, studies exclusively describing health workers performance on management of severe malaria in literature is rare. A mixed method study from Ghana in 2014 looking at health professionals' compliance to guidelines for treatment of severe malaria in children showed good compliance [133]. However, that study was conducted in a hospital setting while the current study is rural based, involving primary health workers. Treatment practices may vary between endemic and non-endemic countries. In December 2012, CDC published in its *Mortality and Morbidity Weekly Report (MMWR)* that severe malaria patients in USA were likely to receive inappropriate treatment after only 11% of severe malaria patients involved in the surveillance were treated according to protocol [134].

The three items that markedly mark down overall practice in Table 24 are inappropriate utilisation of microscopy (88.7%), no administration of artesunate suppository (69.0%) and incorrect reason for advising discharged patients to return for follow up. Microscopy was only in 14.1% of the facilities during the study and

utilisation proportion is expected as a province, though not fair to facilities who did not have microscopy. Making microscopy available to facilities is task that will provincial and national authorities. Educating health workers about artesunate suppository and reasons for following up discharged severe malaria patients are issues that can be addressed at health centre level.

In terms of diagnosis based on RDT, the current study recorded poor diagnostic practice where more than 60% of the participants responded to not reading RDTs results at the recommended time. On the other hand, the perception of RDT among the participants was high. This means the participants believed in RDT but were performing the test incorrectly. The low knowledge observed in this study may have some explanation here, as supported by a cross sectional study from Nigeria in 2016 [83].

Treatment practice in the last national survey, as well as years past, have only focused on uncomplicated malaria. Nevertheless, in severe malaria oral treatment (AL) is recommended after parenteral treatment. In the current study, an impressive 94.4% knew that an oral treatment was recommended after parenteral treatment in severe malaria (not exactly AL), but, only 35.2% knew the correct drug (AL). Although the finding cannot be contrasted with the last national survey (2016), the national survey showed that AL prescription practices with regard to uncomplicated malaria had increased significantly since it was first introduced in 2010 [18]. This implies that the participants would have no difficulty administering AL, but majority did not know that AL is recommended for severe malaria patients after parenteral therapy. The low knowledge is the likely explanation for this scenario.

Follow up practice was good (73.2%) in general. However, a closer look reveals that while 78% would advise discharged severe malaria patients for follow up, on 6% had the correct reason for follow up – (microscopy). This could be due to the low knowledge, negative attitude to clinical practice or unavailability of microscopy. No local study is available for comparison.

5.1.7 Association of Sociodemographic and Economic Factors with Practice

Sex had a relationship with treatment practice in this study; female participants statistically had more odds to conform to guidelines in their treatment practices compared to their male counterparts (p=0.046; OR=2.281; CI=1.017-5.117). Such can be expected because in general, women seem to be more caring than men and is supported by behavioural [135] and evolutionary studies [136]. No local study has compared malaria case management in terms of sex among health workers. Nevertheless, this difference in treatment practice between the two sexes is in agreement with a prospective Tanzanian study conducted among inpatient and outpatient health workers which found that female clinicians were likely to prescribe according to guidelines [55].

Age had an association with diagnostic practice. Participants above 50 years of age were significantly less likely to conform to guidelines with their diagnostic practice when compared to those below 35 years (p = 0.001; OR = 0.1; CI 0.062-0.463). This could be due to the low knowledge, lack of training or negative attitude to clinical practice. In addition, a mere inactivity can have some influence. The finding is similar to a study in Kenya done in 2015 where primary health workers over 40 years were likely to perform better than their counterparts who were less than 40 years (p<0.001) [57]. The obvious difference is that participants in Kenya were supported in training by partners at any other time, while for PNG frequency for training has declined over the last seven years as shown in the 2016 national health facilities survey [41].

Work experience had a relationship with overall practice. Participants with more than 20 years' work experience were less likely (p=0.029; OR=0.181; CI 0.039-0.836) to comply with guidelines in their overall practice. This situation is often witnessed on the ground, which could imply that more experienced health workers are more complacent or over-confident with their practice, or certain practices over the years have become habitual that it is not easy for them to accommodate new changes quickly because this group also had fair experience with the older malaria case management guidelines, or they could be mixed up with the older and current

guideline due to lack of training. Our finding is similar with the PNG survey in 2013 which showed that health workers with 20+ years' experience sought diagnosis less and prescribed more antimalarials while those with less than 20 years' experience sought more diagnosis and prescribed according to results [39].

Participants living without a spouse (single) were more likely to follow up discharged severe malaria patients compared to their married counterparts (p=0.012; OR=6.325; CI 1.149-26.840). The finding could mean that single health workers have more time to think and/or do so than their married counterparts. Whatever the reason, relationship of health workers' marital status and practice is an area yet to be established in PNG with sufficient evidence. No local studies so far have exhausted follow up practice as a separate outcome variable. Nevertheless, the finding here is in contrast with a mixed methods cross-sectional study in Uganda conducted among primary health workers and found no association between marital status and health worker performance [59]. The difference could be because the Ugandan study was done in a setting where the primary health workers were supervised by a medical officer. A study in PNG with further insight would detail the reasons.

Income had an association with treatment practice. Participants earning >K500 per fortnight were statistically less likely to comply to guidelines with their treatment practice as compared to those receiving <K500 per fortnight (p=.034; OR=0.288; CI=0.091-0.908). While 20% of the participants with more than ten years' experience were receiving <K500, the rest were paid above that mark as appropriate. Such finding could be expected in a sense that those lower salary earners in our study were base level positions holders whose job description is exclusively clinical work, while higher positions do mostly administrative and irregular clinical work, thus unlikely to comply. Specific positions of the participants in the facilities were not enquired. There is no local study to compare our finding in this regard, however, the finding is in contrast to a cross sectional study done in Cambodia in 2016 among primary health workers, which found that good income was a major motivator of improved health worker performance [63]. Nevertheless, this Cambodian study was investigating a

performance-based financing where health workers would be provided financial incentives after reaching set targets. It was not a systemic salary adjustment.

In terms of professions, nursing officers were marginally less likely to follow up discharged severe patients compared to MOs and HEOs (p=0.039; OR=0.159; CI=0.028-0.910). This finding is not so surprising considering the knowledge gap between nurses and doctors / HEOs. Doctors and HEOs collectively made up less than 3% of the current study population. No local study taking follow up of discharged severe malaria (or malaria) patients is available for comparison. Apart from overall, diagnostic or treatment practices, specific studies on health worker cadre and follow up of severe malaria patients is also rare in literature. WHO recommends that discharged severe malaria patients should be followed up on day 7, 14 and 28 to monitor recovery [2]. The notion of drug resistance surveillance is also important, where hyperparasitaemia is a risk factor [6].

Other sociodemographic and economic variables did not demonstrate any association after catering for confounders.

5.1.8 Association of Knowledge with Practice

Participants with high knowledge had higher odds of complying with national guidelines in their overall practice compared to those with low knowledge (p=0.001; OR=42.5; 4.239-426.739). This is expected because health workers with good knowledge would have higher odds of complying to guidelines. The last national health facilities survey described that knowledge regarding performance of RDT and administration of treatment for uncomplicated malaria had increased. However, neither management of severe malaria nor associations were assessed [41]. Our study agrees with a mixed method study from Indian in 2017 conducted among physician which found that 73.0% of physicians were complaint and attributed this finding to good knowledge [75].

Participants with high knowledge also had higher odds to follow up discharged severe malaria patients (p=0.013; OR=17.487; 1.845-165.677). This is expected because the

possible sequelae and complications of severe malaria would concern any health worker with good knowledge on the subject. Interestingly, participants with moderate knowledge were less likely to comply with national guidelines in diagnostic practice (p=0.026; OR=0.076; 0.076-0.360). The possible explanations are that the moderate category may be marginally close to low knowledge, or, may lack confidence as show in our study (low self-efficacy, 64.8%). No local study is available for comparison. These hypotheses need further research to confirm.

5.1.9 Association of Attitudes with Practice

Our study revealed that participants with positive attitude to responsiveness were statistically likely to comply with following up discharged severe malaria patients (p=0.017; OR=5.846; CI 1.370-24.943). This association is not surprising considering the fact that a quarter of the participants had positive attitude to responsiveness. It is believed that the initiatives within PNG health system, namely facilities standards and infection control which do promote certain aspects of responsiveness, could have valid explanations for this discovery. There are no local studies to compare the finding of our study. Nevertheless, the finding correlates to some extent with an English study which showed that a holistic approach to patients was associated with good practice [80]. The hypothesis could be that health workers who pay attention to non-health needs, in addition to health needs, could be more caring and diligent in their practice. In addition, holistic practices could be systemised in high income countries. Responsiveness is an area that needs systemic attention in health systems, especially in low and middle-income countries. WHO stated that responsiveness usually lacked in public health service in South East Asia and Western Pacific Regions [130]. A cross-sectional study in Ugandan in 2003 further echoes that there was huge need for health workers to recognise patients' non-health needs [79].

Attitude to clinical practice had no statistical significance with any practice in our study. The reasons could be multiple, but according to the current study the low knowledge and about a quarter having negative attitude to clinical practice could owe some explanation. The 2016 health facilities survey showed high clinical attitude to practice regarding uncomplicated malaria [41], however, no statistical analysis was

published so a comparison cannot be made here. A cross sectional study from Tanzania in 2008 among primary health workers showed that certain attitudes towards malaria case management was influenced by the popularity of malaria as a major public health, and dilutes the attitude of health workers [77].

5.1.10 Association of Perceptions with Practice

Participants with high perceived benefit were more likely to comply with national guidelines in overall practice (p=0.015; OR=6.251; 1.422-27.472) as well as specific treatment practice (p=0.042; OR=2.527; CI 1.032-6.187). This is not surprising because more than 60% of the participants perceive that certain benefits should be accorded if they do perform better in terms of severe malaria case management. This finding is supported by a qualitative study among rural health workers in PNG in 2012 where anticipated community recognition and support were among the performance enhancers [121]. Another similarly designed study in PNG in 2012 showed that little incentives from church facilities boosted health workers to work diligently [126]. Considering the injustice in salaries where some very senior staffs in terms of experience are not paid accordingly, financial incentives for health workers is an area that can be explored. Any measure to rectify benefits may also have a positive ripple effect in attracting younger health workers to work in rural health facilities.

Other constructs of perceptions did not show any statistical association with any practice after multivariate analysis. But it is worth discussing few of these. Perceived severity had no statistical association with any practice. This dissociation was interesting considering the fact that PNG is a malaria endemic country. However, the low knowledge regarding severe malaria among the participants may explain the null association between perceived severity and practice. While there is no local study to do comparison, the finding is in contrast to a cross sectional study conducted in Kenya in 2015 where sick children who presented very sick with danger signs received more care in terms of investigations, including both RDT and microscopy on the same patient, which simply means health workers had high perceived severity of the disease [81]. The tendency to link altered consciousness, convulsions or coma to

supernatural powers cannot be excluded, especially in a culture such as PNG where sorcery is embedded, and thus diluting perceived severity of severe malaria cases. This is supported by a study done in rural Tanzania in 2007, where sorcery is common, where rural health workers do allude possible symptoms of severe malaria to sorcery [137]. Further investigation is warranted in this area.

5.1.11 Association of Cues with Practice

Participants exposed to unfavourable cues were statistically less likely to follow up discharged patients (p=0.005; OR=0.153; CI=0.041-0.575). In our study cues to practice included trainings, supervision, data feedback, availability of malaria consumables and accessibility to the treatment guideline. The general picture was that majority (60%) were exposed to favourable cues, but a closer look reveals that training was lacking (18.3%) and supervision was also not so impressive (43.7%). This could explain the finding above. Although successive local health facilities surveys have quantified different cues, no association with health workers performances have been published, thus, any comparison cannot be made with the current study. Nonetheless, our finding is similar with a randomised controlled trial in Nigeria which found that those not exposed to training or supervision performed poorly on malaria case management, while improved performance was noted in the intervention (training) group [91].

Our study reveals widespread availability of malaria consumables and accessibility to the treatment guidelines, which is similar to the 2016 national health facilities survey [41]. Hence, the negative association between cues and follow up observed in our study could mean that despite the availability of malaria commodities, health workers needed training and supervision for learning and motivation to manage severe malaria patients according to national guidelines.

5.1.12 Limitations of the study

- All responses were not objectively verified, which could have increased the validity, especially for some variables such as treatment charts and malaria consumables.

- Convenient sampling was applied to select the participants – health workers on duty on the interview day were recruited. A random selection would increase external validity of the study. However, despite convenient sampling, the sociodemographic characteristics of participants in our study were similar to the national figures as per the 2016 national health facilities surveys: CHWs in the current study were 62% while in the national survey was 68%; nursing officers in the current study were 31% while in the national survey was 25.8%; HEOs in the current study was 5.6% while in the national survey was 5.7% [41]. Therefore, the results can be generalised to the sample population to some extent, though not exclusively.
- Economic status of the participants was supposed to be measured using 'wealth index,' which is a valid measure of the actual wealth in developing countries. However, because the country was yet to incorporate this tool, income was used in this study.
- The ethical committee recommended for a change in study site – from the initially planned urban setting to a rural setting. Logistical arrangements were a challenge and forced reduction in the duration of data collection. As a result, in most facilities questionnaires were dropped off and picked up later in the afternoon or day(s) later.
- Causation effect cannot be established as this was a cross sectional study.

5.1.13 Strengths of the study

- This was the first study exclusively assessing practice regarding severe malaria among health workers in PNG.
- This is the first study in PNG in which statistical analysis has been done to cater for confounders and find out predictors to certain behaviours regarding management of severe malaria.

5.2 Conclusion

The general objective of the study was to describe and find associations between modifying variables, individual attitudes and perceptions, cues to practice and practice regarding severe malaria among health workers in Central Province, PNG. Our findings can be summarised as follows:

- More than half of the participants were non-compliant to national guidelines in their current overall practice regarding severe malaria.
- Participants with a positive attitude to responsiveness were likely to follow up discharged severe malaria patients. Given the fact that responsiveness does not get much attention in PNG, this finding was enlightening and definitely a call to further strengthen initiatives within PNG health system that promote elements of responsiveness. Participants who followed up patients are diligent and so likely to accord the same practice in other diseases as well, apart from malaria.
- The level of knowledge was a predictor in several areas of practice regarding severe malaria. High knowledge was a predictor of compliant overall practice and following up practices. Moderate knowledge was a predictor of participants less likely to comply with diagnostic practice. Despite access to guidelines and availability of malaria commodities for managing severe malaria cases, there is need for training and supportive supervision, and make sense of data that has been shared on average.
- Participants exposed to unfavourable cues were less likely to follow up discharged patients. Given the wide availability of malaria commodities, the cues here are more likely training and supervision.
- High perceived benefit was a predictor to complaint overall and diagnostic practice regarding severe malaria. The benefits could be monetary or non-monetary as supported by other PNG studies.

The hallmark seems to be staff motivation through knowledge transfer and providing incentives (monetary or non-monetary). Training and supervision appear to be critical, followed by other cues. When there is good staff knowledge and morale, the motivation and tendency to adhere to guidelines in terms of diagnosis, treatment and

follow up of discharged severe malaria patients is there, in the process non-health needs (responsiveness) has been catered for.

5.3 Recommendations

5.3.1 Recommendation for Future Research

- In future studies on factors influencing practice regarding severe malaria, researchers should use checklists for verification of the items to covered to increase validity of data. The PNGIMR who does routine health facility surveys should develop checklists on severe malaria and start using in the next health facility survey (2020). The checklist should include staff training attendance, RDT availability and performance, microscopy skill and consumables, drugs, clinical checklist and evaluation form.
- Multiple sampling technique in such research is inevitable, but in the future researchers should use randomisation to select participant (health workers) to increase external validity of results.
- In future studies, economic status should be measured with the valid 'wealth index', and it should be objectively assessed. Wealth index is the valid tool to measure wealth in developing countries. Health workers in rural areas often do have other sources of income, or own assets that represents wealth in respective local contexts. Therefore, wealth index would be applicable rural health workers.
- In the future the ethical committee (PNG MRAC) needs to consider duration when deliberating to students' academic research. Unlike real research, school assignments are strictly bound by time. This may sound like requesting the committee to compromise, but that is not an option. A well-thought-out balance has to be struck.
- Knowledge stands out to be one of the main factors influencing practice regarding severe malaria in the study, however, the cross-sectional nature of the study cannot give any cause effect. Future studies should apply other designs such as qualitative studies to explore possible reason some apparent

mismatch, for example, negative attitude to clinical practice. Or, randomised controlled trials or other comparative studies to confirm findings in our study.

5.3.2 Recommendations for Program / Policy Makers

- The national and provincial malaria programs need to come up with a plan to roll out trainings on severe malaria to health facilities to increase knowledge of health workers.
- A policy for supportive supervision should be developed. The policy should identify the purpose of supervision, the implementation process including the responsibilities of personnel undertaking the supervision and the role of staff being supervised. Supervision to lower health facilities by national and provincial officers should be routine, and performance of health workers should be followed up.
- National data on malaria (including severe malaria) needs to be made available to provinces on regular basis. This should be done by both provincial as well as national officers through collaboration. Partners implementing different project under malaria can be utilised in the process.
- The lack of malaria microscopy services will have implications at patient level, health facility level as well as program level. Microscopy is the recommended modality for following up discharged severe malaria patients to ensure patients achieve parasite clearance and also drug resistance surveillance. Therefore, microscopy services need to be revitalised. The provincial government with support from national government as well as stakeholders need to purchase microscopies where they are needed. Most health facilities have malfunctioning microscopy that need maintenance, or microscopists who need refresher training. The regular WHO-sanctioned external training and assessment for malaria microscopists need to be utilized to the maximum. The Central Provincial government needs to struck dialogue with WHO to access this service.
- A national and provincial authorities need to come up with strategies to address the already existing aging workforce, and the looming crisis that could

prove disastrous in the next decade. The provincial government should plan to retire those approaching retirement age, and upgrade positions and introduce certain benefits to lure young health workforce to rural health facilities.

- The provincial human resource section needs to review salaries of all health workers in primary health facilities and identify those whose salaries need to be upgraded so that health workers are compensated appropriately and well.
- Wealth index in the valid measurement for wealth in third world countries. Income alone is not sufficient, thus, not valid. As such, the National Statistical Office in collaboration with the local United Nations office need to step up and validate a wealth index tool for Papua New Guinea. The PNG National Statistical Office, in collaboration with UNDP or World Bank should develop a wealth index tool for the country immediately. As much as possible, it should be used in the next malaria indicator survey, health facilities survey or demographic health survey.

REFERENCES

1. Centre for Disease Control and Prevention, *Malaria Parasites*, in *CDC Malaria*, C.f.D.C.a. Prevention, Editor. 2016, CDC: Atlanta.
2. World Health Organisation, *Management of Severe Malaria: a practical handbook* 2012(3rd edition).
3. Bilal Ahmad Rahimi, et al., *Severe vivax malaria: a systematic review and meta-analysis of clinical studies since 1900.* Malaria Journal, 2014. **13**(481).
4. Janet Cox-Singh, T.M.E.D., Kim-Sung Lee, Sunita S. G. Shamsul, Asmad Matusop, Shanmuga Ratnam, Hasan A. Rahman, David J Conway, Balbir Singh, , *Plasmodium knowlesi malaria in humans is widely distributed and potentially life-threatening.* Clinical Infectious Diseases, 2008. **46**: p. 165–171.
5. Kantele A and Jokiranta S, *Review of cases with the emerging fifth human malaria parasite, Plasmodium knowlesi.* . Clinical Infectious Diseases, 2011. **52**: p. 1356–1362.
6. Organisation, W.H., *Guidelines for the treatment of malaria, 3rd edition, 2015.* 2015.
7. Organisation, W.H., *World Malaria Report 2016.* 2017.
8. Organisation, W.H., *World Malaria Report 2015.* 2016.
9. Richard E. Cibulskis, et al., *Malaria: Global progress 2000 – 2015 and future challenges.* Infect Dis Poverty, 2016. **5**(61).
10. Health, P.N.G.N.D.o., *Papua New Guinea National Malaria Strategic Plan, 2014 – 2020.* 2016.
11. World Health Organisation, *World Malaria Report 2013.* World Malaria Report, 2014. **2013**(World Health Organisation): p. Geneva, Switcherland.
12. Mueller I, et al., *High sensitivity detection of Plasmodium species reveals positive correlations between infections of different species, shifts in age distribution and reduced local variation in Papua New Guinea.* Malaria Journal 2009. **8**(41).
13. Rogerson SJ and Carter R, *Severe vivax malaria: newly recognised or rediscovered.* PLoS One Med, 2008. **5**(6): p. 136.
14. Genton B, et al., *Plasmodium vivax and mixed infections are associated with severe malaria in children: a prospective cohort study from Papua New Guinea.* PLoS Med. , 2008. **5**(6): p. 127.
15. Lalloo DG, et al., *Severe and complicated falciparum malaria in Melanesian adults in Papua New Guinea.* Am J Trop Med Hyg, 1996. **55**(2): p. 119-24.
16. Mishra SK, et al., *Management of severe and complicated malaria.* J Postgrad Med, 2006. **52**(4): p. 281-7.
17. Mueller I, et al., *The epidemiology of malaria in Papua New Guinea.* Trends Parasitol, 2003. **19**(6): p. 253-9.
18. Research., P.N.G.I.o.M., *THE PAPUA NEW GUINEA NATIONAL MALARIA CONTROL PROGRAM: PRIMARY OUTCOME & IMPACT INDICATORS, 2009-2014, ,* in *NMCP Evaluation,*. 2015, PNGIMR. p. 11.
19. Health, P.N.G.N.D.o., *National Health Information System 2015.* Papua New Guinea National Department of Health 2016.
20. Health, P.N.G.N.D.o., *National Health Information System 2016.* 2017.
21. Health, P.N.G.N.D.o., *National Malaria Treatment Protocol 1st ed.* 2009.

22. Organisation, W.H., *Severe Malaria. Section 1: Epidemiology of severe falciparum malaria* Tropical Medicine and International Health, 2014. **19 Supplement**.
23. Organisation, W.H., *Severe Malaria.* Tropical Medicine and International Health 2014. **19**(1): p. 7-131.
24. Reyburn H, et al., *Overdiagnosis of malaria in patients with severe febrile illness in Tanzania: a prospective study.* BMJ,, 2004. **20**(7476): p. 1212.
25. Terrie E Taylor, et al., *Differentiating the pathologies of cerebral malaria by postmortem parasite counts.* Nature Medicine, 2004. **10**: p. 143-145.
26. Bhattarai A, et al., *Impact of artemisinin-based combination therapy and insecticide-treated nets on malaria burden in Zanzibar.* . PLoS Med., 2007. **4,**: p. e309.
27. Graves PM, et al., *Effectiveness of malaria control during changing climate conditions in Eritrea, 1998-2003.* Trop Med Int Health., 2008. **13**: p. 218-228.
28. Teklehaimanot HD, et al., *Malaria in Sao Tome and principe: on the brink of elimination after three years of effective antimalarial measures.* American Journal of Tropical Medicine and Hygiene, 2009. **80**(133-140).
29. Steketee RW and Campbell CC, *Impact of national malaria control scale-up programmes in Africa: magnitude and attribution of effects.* . Malar J, 2010. **55,**: p. 24-32.
30. Sheila S Mudenda, et al., *Feasibility of using a World Health Organization-standard methodology for Sample Vital Registration with Verbal Autopsy (SAVVY) to report leading causes of death in Zambia: results of a pilot in four provinces, 2010.* BMJ,, 2011. **9**: p. 40.
31. Dondorp A and Day N, *The treatment of severe malaria.* Trans R Trop Med Hyg. , 2007. **101**(7): p. 633-4.
32. D. I. Stanisic, et al., *Robert Koch redux: malaria immunology in Papua New Guinea.* European Journal of Immunology, 2010. **32**(8): p. 623-632.
33. Lars Hviid, *Naturally acquired immunity to plasmodium falciparum malaria in Africa.* Acta Tropica, 2005. **95**: p. 270-275
34. COHEN S, McGREGOR IA, and CARRINGTON S, *Gamma-globulin and acquired immunity to human malaria.* Nature, 1961(192): p. 733-7.
35. I. A. McGREGOR and R. J. M. WILSON, *PRECIPITATING ANTIBODIES AND IMMUNOGLOBULINS IN P. FALCIPARUM INFECTIONS IN THE GAMBIA, WEST AFRICA* TRANSACTIONS OF THE ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE, 1971. **65**(2).
36. Azra C. Ghani, et al., *Loss of Population Levels of Immunity to Malaria as a Result of Exposure-Reducing Interventions: Consequences for Interpretation of Disease Trend.* PLoS ONE., 2009. **4**(2): p. e4383. .
37. Neil Nicholls and K.C. (editors), *Malaria Diagnosis and the New Treatment Protocol: A training manual for health workers in Papua New Guinea.* National Competency Training Project Divine Word University, 2010.
38. Justin Pulford, et al., *Malaria case management in Papua New Guinea prior to the introduction of a revised treatment protocol.* Malar J, 2012. **11**: p. 157.
39. Justin Pulford, et al., *Malaria case management in Papua New Guinea following the introduction of a revised treatment protocol.* Malar J., 2013. **12**(433).

40. Justin Pulford, et al., *Health Worker Compliance with a 'Test And Treat' Malaria Case Management Protocol in Papua New Guinea* PLoS One 2016. **11**(7).
41. SERAH F KURUMOP, et al., *THE PAPUA NEW GUINEA NATIONAL MALARIA CONTROL PROGRAM:*

HEALTH FACILITY SURVEYS 2010-2016. 2016.
42. Organisation, W.H., *Integrated Management of Childhood Illnesses.* Geneva, 2012. **Switzerland:**(WHO.).
43. Organisation, W.H., *Integrated Management of Adult and Adolescent Illnesses.* 2005.
44. Beatrice Autino, et al., *Pathogenesis of Malaria in Tissues and Blood.* Mediterr J Hematol Infect Dis, 2012. **4**(1): p. e2012061. .
45. Arjen M.Dondorp, Emsri Pongponratn, and Nicholas J.White, *Reduced microcirculatory flow in severe falciparum malaria: pathophysiology and electron-microscopic pathology.* Acta Tropica, 2004. **89**(3): p. 309-317.
46. Dondorp AM, et al., *Artesunate versus quinine in the treatment of severe falciparum malaria in African children (AQUAMAT): an open-label, randomised trial.* Lancet., 2010. **376**(1647-57).
47. Dondorp A, et al., *South East Asian Quinine Artesunate Malaria Trial Group. Artesunate versus quinine for treatment of severe falciparum malaria: a randomised trial.* Lancet., 2005. **366**: p. 717–25.
48. Organisation, W.H., *World Malaria Report 2013*, in *World Malaria Report*, W.H. Organisation, Editor. 2014, World Health Organisation: Geneva, Switcherland.
49. United Nations Development Project in Collaboration with WHO and PNG NDoH, *Papua New Guinea Health Service Delivery Profile 2012,.* UNDP Publishing., 2012,.
50. Divine Word University, *Department of Health Extension (Rural Health).* University Press,, 2017,. **Divide Word University,** (Papua New Guinea.).
51. Mark Anthony Gregorio, *A Glimpse of the Healthcare Workforce in Papua New Guinea,.* Global Health Fellows: Pfizer Investments in Health, 2011,.
52. CL Pilang, M.G., FI Oprescu, , *RURAL HEALTH HISTORY: The evolution of the Community Health Worker program in Papua New Guinea,.* The International Electronic Journal of Rural and Remote Health Research, Education, Practice and Policy,, 2017,. **17:**: p. 3961.
53. Jane Achan, et al., *Case Management of Severe Malaria - A Forgotten Practice: Experiences from Health Facilities in Uganda.* PLoS One, 2011. **6**(3).
54. Ashwell HE and Freeman P, *The clinical competency of community health workers in the eastern highlands province of Papua New Guinea.* P N G Med J, 1995. **38**(3): p. 198-207.
55. Clare I. R. Chandler, et al., *The importance of context in malaria diagnosis and treatment decisions - a quantitative analysis of observed clinical encounters in Tanzania.* Tropical Medicine and International Health, 2008. **13**(9): p. 1131-1142.

56. Naimoli JF, et al., *Effect of the Integrated Management of Childhood Illness strategy on health care quality in Morocco.* International Journal for Quality in Health., 2006(18): p. 134-144

57. Yoshito Kawakatsu, et al., *Factors influencing the performance of community health workers in Kisumu West, Kenya.* Primary Health Care Research & Development., 2012. **13**(4): p. 294-300.
58. Danjuma A. Bello, et al., *Knowledge and pattern of malaria case management among primary health-care workers in Jos.* Journal of Medicine in the Tropics 2013. **15**(2): p. 91-95.
59. Phillip Wanduru, et al., *The performance of community health workers in the management of multiple childhood infectious diseases in Lira, northern Uganda – a mixed methods cross-sectional study.* Global Health Action, 2016. **9**(33194).
60. Bellgam IH and Buowari YO, *Influence of religious beliefs on health workers, a pilot study.* Niger J Med., 2014. **23**(3): p. 245-7.
61. Elena Salmoirago-Blotcher, et al., *An exploration of the role of religion/spirituality in the promotion of physicians' wellbeing in Emergency Medicine.* Prev Med Rep., 2016. **3**: p. 189-195.
62. Guinea, G.o.P.N., *National Census 2011*, D.o.N. Planning, Editor. 2011.
63. Khim, K., *Are health workers motivated by income? Job motivation of Cambodian primary health workers implementing performance-based financing,.* Global Health Action, (2016). **9:**(1,).
64. Shen, G.C.e.a., *Incentives to change: effects of performance-based financing on health workers in Zambia,.* BMC Human Rsources for Health., (2017). **15**(20).
65. Songstad, N.G., *Health worker motivation in a low-income context.* (2012),. **PhD Dissertation.**(University of Berden, Tanzania.).
66. Alinune N. Kabaghe, et al., *Health workers' compliance to rapid diagnostic tests (RDTs) to guide malaria treatment: a systematic review and meta-analysis.* Malar J., 2016. **15**(163): p. 1215-8.
67. Majige Selemani, et al., *Health worker factors associated with prescribing of artemisinin combination therapy for uncomplicated malaria in rural Tanzania.* Malaria Journal 2013. **12**(334).
68. Laura C Steinhardt, et al., *Patient-, health worker-, and health facility-level determinants of correct malaria case management at publicly funded health facilities in Malawi: results from a nationally representative health facility survey.* Malar J, 2014. **13**: p. 64.
69. Zurovac, D., et al., *Predictors of the Quality of Health Worker Treatment Practices for Uncomplicated Malaria at Government Health Facilities in Kenya.* International Journal of Epidemiology, , 2004. **33**(5): p. 1080-1091.
70. Ucakacon, P.S., et al., *Prescribing Practices for Malaria in a Rural Ugandan Hospital: Evaluation of a New Malaria Treatment Policy.* African Health Sciences, 2011. **11**: p. 53-59.
71. Delanyo, D., *Using Mid-Level Cadres as Substitutes for Internationally Mobile Health Professionals in Africa. A Desk Review.* . Human Resources for Health, 2004. **2**(7).

72. Kakeeto, S., et al., *Anti-Malarial Targeting and Dosing Practices among Health Workers at Lower Level Health Facilities in Uganda* Health, 2014. **6**: p. 2154-2161.
73. Majige Selemani, et al., *Health worker factors associated with prescribing of artemisinin combination therapy for*

uncomplicated malaria in rural Tanzania. Malaria Journal, 2013. **12**: p. 334.
74. Cristolde A. Salomão, et al., *Prescription practices for malaria in Mozambique: poor adherence to the national protocols for malaria treatment in 22 public health facilities.* Malar J, 2015. **14**: p. 483.
75. Kathirvel S, et al., *Physicians' compliance with the National Drug Policy on Malaria in a tertiary teaching hospital, India, from 2010 to 2015: a mixed method study.* Transactions of The Royal Society of Tropical Medicine and Hygiene,, 2017. **111**(2): p. 62-70.
76. Watsierah CA, et al., *Provider knowledge of treatment policy and dosing regimen with artemether-lumefantrine and quinine in malaria-endemic areas of western Kenya.* Malar J, 2012. **11**: p. 436.
77. Clare IR Chandler, et al., *Guidelines and mindlines: why do clinical staff over-diagnose malaria in Tanzania? A qualitative study.* Malar J, 2008. **7**: p. 53.
78. Andrew Nyandigisi, et al., *Malaria Case-Management following Change of Policy to Universal Parasitological Diagnosis and Targeted Artemisinin-Based Combination Therapy in Kenya.* PLoS One., 2011. **6**(9): p. e24781.
79. Harriet Rachel Kagoya, et al., *Awareness of, responsiveness to and practice of patients' rights at Uganda's national referral hospital.* Afr J Prim Health Care Fam Med., 2013. **5**(1): p. 491.
80. Souraya Sidani, et al., *Exploring Differences in Patient-Centered Practices among Healthcare Professionals in Acute Care Settings.* Health Communication . 2017. **0**(0): p. 1-8.
81. Frankline M Onchiri, et al., *Frequency and correlates of malaria over-treatment in areas of differing malaria transmission: a cross-sectional study in rural Western Kenya.* Malar J, 2015. **14**: p. 97.
82. Mubi M, et al., *Malaria diagnosis and treatment practices following introduction of rapid diagnostic tests in Kibaha District, Coast Region, Tanzania.* Malar J., 2013. **12**(293).
83. Oluyomi F. Bamiselu, et al., *Adherence to malaria diagnosis and treatment guidelines among healthcare workers in Ogun State, Nigeria.* BMC Public Health 2016. **16**: p. 826.
84. David Sears, et al., *Anti-malarial prescription practices among outpatients with laboratory-confirmed malaria in the setting of a health facility-based sentinel site surveillance system in Uganda.* Malar J., 2013;. **12:**: p. 252.
85. SERAH F KURUMOP, et al., *THE PAPUA NEW GUINEA NATIONAL MALARIA CONTROL PROGRAM: HEALTH FACILITY SURVEYS 2010-2016.* 2016.
86. Chandler CI, et al., *The development of effective behaviour change interventions to support the use of malaria rapid diagnostic tests by Tanzanian clinicians.* Implement Sci., 2014. **9**(83).

87. Uzochukwu BSC, et al., *Improving rational treatment of malaria: perceptions and influence of RDTs on prescribing behaviour of health workers in Southeast Nigeria.* PLoS One., 2011. **6**(e14627).
88. Ofori-Adjei D1 and Arhinful DK, *Effect of training on the clinical management of malaria by medical assistants in Ghana.* Malar J, 1996. **42**(8): p. 1169-76.
89. Kathleen Abrahamson, Priscilla Arling, and Jenna Gillette, *Does self-efficacy influence the application of evidence-based practice: A survey and structural equation model.* . Journal of Nursing Education and Practice., 2013. **3**(5).
90. Takele Kefyalew, et al., *Health worker and policy-maker perspectives on use of intramuscular artesunate for pre-referral and definitive treatment of severe malaria at health posts in Ethiopia.* Malar J. , 2016. **15**(507): p. 1561-6.
91. Billy Ngasala, et al., *Impact of training in clinical and microscopy diagnosis of childhood malaria on antimalarial drug prescription and health outcome at primary health care level in Tanzania: A randomized controlled trial.* Malar J., 2008. **7**: p. 199.
92. Wilfred FMbacham, et al., *Basic or enhanced clinician training to improve adherence to malaria treatment guidelines: a cluster-randomised trial in two areas of Cameroon.* Lancet., 2014. **2**(6): p. e346-e358.
93. Ruth J. Namuyinga, et al., *Health worker adherence to malaria treatment guidelines at outpatient health facilities in southern Malawi following implementation of universal access to diagnostic testing.* Malar J, 2017. **16**(40): p. 1693.
94. J. Eriksen, et al., *Assessing health worker performance in malaria case management of underfives at health facilities in a rural Tanzanian district.* Tropical Medicine and International Health, 2006. **12**(1): p. 52-61.
95. Dejan Zurovac, et al., *Major Improvements in the Quality of Malaria Case-Management under the "Test and Treat" Policy in Kenya.* PLoS One, 2014. **9**(3): p. e92782. .
96. Laura C. Steinhardt, et al., *Quality of Malaria Case Management in Malawi: Results from a Nationally Representative Health Facility Survey.* PLoS One, 2014. **9**(2): p. e89050. .
97. Osterholt DM, et al., *Predictors of treatment error for children with uncomplicated malaria seen as outpatients in Blantyre district, Malawi.* . Trop Med Int Health., 2006. **11**: p. 1147-56.
98. Rowe AK, et al., *Predictors of correct treatment of children with fever seen at outpatient health facilities in the Central African Republic.* . Am J Epidemiol. , 2000. **151**: p. 1029-35.
99. Zurovac D and Rowe AK, *Quality of treatment for febrile illness among children at outpatient facilities in sub-Saharan Africa.* . Ann Trop Med Parasitol. , 2006. **100**: p. 283-96.
100. Onwujekwe O, et al., *Quality of anti-malarial drugs provided by public and private healthcare providers in south-east Nigeria.* . Malar J. , 2009. **8**: p. 22.
101. Asadu Sserwanga, et al., *Improved Malaria Case Management through the Implementation of a Health Facility-Based Sentinel Site Surveillance System in Uganda.* Malar J, 2011. **6**(1): p. e16316. .

102. World Health Organisation, *Training for mid-level managers (MLM): Module 4. Supportive supervision,*. WHO Library Cataloguing in Publication Data., 2008,.
103. A. Asante, G.R., *Strengthening supportive supervision at the district health level in the Pacific,*. Human Resources for Health Knowledge Hub,, 2011,. **Policy Brief,**(University of New South Wales.).
104. Ryota Hase, *Diagnostic delay for imported malaria: A case of Plasmodium falciparum malaria misdiagnosed as common cold.* J Gen Fam Med., 2018. **19**(1): p. 27-29.
105. Kelly Harchut, et al., *Over-diagnosis of malaria by microscopy in the Kilombero Valley, Southern Tanzania: an evaluation of the utility and cost-effectiveness of rapid diagnostic tests.* Malar J, 2013. **12**: p. 159.
106. Sinclair D, D.S., Isba R, Lalloo DG,, *Artesunate versus quinine for treating severe malaria.* . Cochrane Database Syst Rev. , 2012. **6**(CD005967.).
107. Kurth, F.e.a., *Severe malaria in Europe: an 8-year multi-centre observational study* Malar J, 2017. **16**: p. 57.
108. Makumbe B, et al., *Evaluation of severe malaria case management in Mazowe District, Zimbabwe, 2014.* Pan Afr Med J. , 2017. **11**(27): p. 33.
109. Victoria L. Champion and Celette Sugg Skinner, *THE HEALTH BELIEF MODEL* in *HEALTH BEHAVIOR AND HEALTH EDUCATION Theory, Research, and Practice*. 2008, Jossey-Bass: John Wiley & Sons, Inc. . p. 46-62.
110. Janz KJ and Becker MH, *The Health Belief Model: A Decade Late.* Health Education Quarterly, 1984. **11**(1): p. 1-47.
111. KH., B., *Driving while under the influence of alcohol: Relationship to attitudes and beliefs in a college population.* Am J Drug Alcohol Abuse. , 1981. **8**: p. 377-388.
112. Israel Mitiku and A. Assefa., *Caregivers' perception of malaria and treatment-seeking behaviour for under five children in Mandura District, West Ethiopia: a cross-sectional study*. Malar J, 2017. **16**: p. 144.
113. Sara Dolnicar, et al., *Three good reasons NOT to use five and seven point Likert items*, in *Archive*, A. University of Wollongong, Editor. 2011, Faculty of Commerce - Papers (Archieve): Adelaide.
114. Malaria., R.B., *Malaria Behaviour Change Communication (BCC) Indicator Reference Guide.* World Malaria Organisation, 2014. **Geneva, Switcherland.** .
115. Ronna C. Turner and L. Carlson., *Indexes of Item-Objective Congruence for Multidimensional Items,.* International Journal of Testing, , 2003. **3**(2): p. 163-171, .
116. Connelly, L.M., 411-2., *Pilot studies.* . Medsurg Nursing,, (2008). **17**(6,): p. 411-2.
117. Mohsen Tavakol and R. Dennick., *Making Sense of Cronbach's Alpha.* International Journal of Medical Education. , 2011. **2**: p. 53-55.
118. World Health Organisation, *Global Atlas of the Health Workforce,*. World Health Report 2006., 2006,.
119. World Bank, *Rapid Aging in East Asia and Pacific Will Shrink Workforce and Increase Public Spending,*. The World Bank,, 2015.

120. Gisèle Irène Claudine Mbemba, M.-P.G., Louise Hamelin-Brabant,, *Factors Influencing Recruitment and Retention of Healthcare Workers in Rural and Remote Areas in Developed and Developing Countries: An Overview,.* Journal of Public Health in Africa,, 2016,. **7,**(2:): p. 565.
121. Rohan Jayasuriya, M.W., Grace Halim,Tim Matineau,, *Rural health workers and their work environment: the role of inter-personal factors on job satisfaction of nurses in rural Papua New Guinea,.* BMC Health Services Research., (2012),. **12**: p. 156.
122. Saadoun F.Alazmib, D.M.A., Aminah A.Atwan, Mohammed IbrahimKamel, Medhat K.El-Shazlya,, *Gender difference of knowledge and attitude of primary health care staff towards domestic violence,.* Alexandria Journal of Medicine,, (2011),. **47,**(4,): p. 337-341.
123. OECD/World Health Organisation, *Health at a Glance Asia/Pacific 2012,.* OECD Publishing., (2012),.
124. Saswata Banerjee, O.F., John Aubery Rennie, Jaffer Balyejjusa, Michael Walsh, , *Bridging the health gap in Uganda: The surgical role of the clinical officer,.* African Health Sciences, 2005,. **5**(1): p. 86-89.
125. Papua New Guinea Government, *Public Service General Orders,.* Government Printing,, (2016),.
126. Jayasuriya R, R.H., Bretnall L, Whittaker M, Yap L, Chakumai K. , *Voices from the field: Factors Influencing Rural Health Workers Performance in Papua New Guinea.* University of New South Wales, Sydney., (2011).
127. Prachi Salve, S.Y., *Poor Salaries, Training Impede Health Work,.* The Hans India,, (2017),.
128. David McCoy, S.B., Sophie Witter, Bob Pond, Brook Baker, Jeff Gow, Sudeep Chand, Tim Ensor, Barbara McPake,, *Salaries and incomes of health workers in sub-Saharan Africa,.* Lancet., (2008),. **371,**: p. 675-681.
129. Research, P.N.G.I.o.M., *Papua New Guinea National Malaria Indicator Survey 2016-2017.* 2018.
130. World Health Organisation, *People at the Centre of Health Care - Harmonizing mind and body, people and systems.* WHO Library Cataloguing in Publication Data., 2007,.
131. Olatunde Adesoro, C.S., John Kpamor, Jane Achan, Harriet Kivumbi, John Dada, Kolawole Maxwell, James Tibenderana, Madeline Marasciulo, Prudence Hamade, Olusola Oresanya, Joanita Nankabirwa, Ebenezer Baba,, *Health worker perspectives on the possible use of intramuscular artesunate for the treatment of severe malaria at lower-level health facilities in settings with poor access to referral facilities in Nigeria: a qualitative study,.* BMC Health Services Research., 2016,. **16,**: p. 566,.
132. Jayasuriya R, R.H., Whittaker M, Yap L, Brentnall L,, *Listening to the rural health workers in Papua New Guinea - the social factors that influence their motivation to work.* Social Science & Medicine, 2012,. **75**(5): p. 828-35.
133. Justina C. Zoyah, A.L.D., *Health Professionals' Compliance with National Treatment Guidelines for Treatment of*

Severe Malaria in Children in Bolgatanga Hospital, Upper East, Ghana. International Journal of Humanities and Social Science,, (2014),. **4,**(1,): p. 119-133.

134. Karen A. Cullen, P.M.A., *Malaria Surveillance — United States, 2012,.* Morbidity and Mortality Weekly Report (MMWR). (2012),. **63**(ss12): p. 1-22,.
135. M J Wade, S.M.S., *Bateman (1948): pioneer in the measurement of sexual selection,.* Heredity,, (2010),. **105,**: p. 507-508.
136. LeeBenshoof, R., *The evolution of monogamy and concealed ovulation in humans.* Social and Biological Structures, , (1979),. **2,**(2,): p. 95-106.
137. Marian Warsame, O.K., Zena Machinda, Patricia Ruddy, Majaha Melkisedick, Thomas Peto, Isabela Ribeiro, Andrew Kitua, Goran Tomson, Melba Gomes,, *Recognition, Perceptions and Treatment Practices for Severe Malaria in Rural Tanzania: Implications for Accessing Rectal Artesunate as a Pre-Referral,.* ploS One,, 2007,. **2**(1): p. e149.
138. Rylance G, *Privacy, Dignity and Confidentiality: interview study with structured questionnaire.* **BMJ,**, 1999. **318**: p. 301.
139. Beauchamp T and Childress J, *Principles of Biomedical Ethics. 3rd edition.* Oxford: Oxford University Press., 1989.

APPENDIX

APPENDIX 1: ADMINISTRATION AND TIME SCHEDULE

Activity	1st month (February 2018)				2nd month (March 2018)				3rd month (April 2018)				4th month (May 2018)				5th month (June 2018)				6th month (July 2018)		
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4			
Proposal preparation																							
Proposal examination																							
Proposal submission																							
PNG Ethical Approval																							
Administrative processes																							
Data collection																							
Report writing and submission																							
Thesis defence & final draft upload																							

APPENDIX 2: BUDGET

No	Item	Cost per unit in PNG Kina	Cost per unit in Thai Baht	Duration	Unit	Cost
2	Logistics arrangements in PNG, including transport costs.	1000	10,000 baht			10,000 baht
3	Payment for research assistant	350	3500 baht	1 day	1	3500 baht
4	Payment for driver		3500 baht	14 days	1	3500 baht
5	Fuel	2000	20,000			20,000
6	Data Management	350	1000 baht		1	3,000 baht
7	Thesis booklet binding, including drafts	500	5,000 baht		5	5,000 baht
	TOTAL	**1900**	19,000 baht			**45,000 baht**

APPENDIX 3: RESPONDENT INFORMATION

1. Introduction

My name is Leonard R. Nawara and I am a postgraduate student at Chulalongkorn University in Bangkok, Thailand. As a requirement to fulfil academic requirements of the university, we are required to do a research and submit a thesis. I have decided to do my study on health workers' behaviour towards management of severe malaria.

Name of principal researcher: Leonard Rakhuna Nawara (Dr)
Phone number: +675 71833572
Email address: leonardnawara@gmail.com

The topic of the study is:
"FACTORS INFLUENCING PRACTICE REGARDING SEVERE MALARIA AMONG HEALTH WORKERS IN CENTRAL PROVINCE, PAPUA NEW GUINEA."
You are now being cordially invited to participate in this study. You can continue on reading this information sheet and after weighing out the benefits, and risks if any, you are free to decide wheather to continue on with the study on not. If your need further clarification on anything. Please do not hesitate to ask the principal researcher or the research assistant.

2. Contents of the questionnaire

The research involves filling out a self-administered questionnaire. Apart from writing your age and the tertiary institution you attended, the whole questionnaire is just about 'ticking boxes' has your answers. In view of your time, it has been made simple for you. Sections of the questionnaire are on socio-demographic characteristics, socio-economic characteristics, knowledge of severe malaria, attitude towards the patient, attitude towards non-health needs, perceptions, factors that prepare you for certain actions (cues), and practice regarding severe malaria.

3. Objectives of the Research

The detailed objective of the study are as follows:
General Objective;

To describe the characteristics and practice regarding severe malaria among primary health care workers, and to assess any association between these characteristics and practice regarding severe malaria among health workers among health workers in CP, PNG.

Specific Objective(s)

1. To find out the modifying factors (socio-demographic characteristics, socio-economic characteristics, professional characteristics, knowledge level) on practice regarding severe malaria among primary health care workers in CP, PNG?

2. To find out the individual beliefs (perceived susceptibility, perceived severity, perceived barriers, perceived benefits, self-efficacy, responsiveness (and attitude)) on practice regarding severe malaria among primary health care workers in CP, PNG?
3. To find out the cues to practice regarding severe malaria among primary health care workers in CP, PNG?
4. To determine the current practice regarding severe malaria among health workers in CP, PNG?
5. To assess any relationship between modifying factors, individual beliefs and cues to practice regarding severe malaria among primary health care workers in CP?

The summaries of the objectives of the study are as:

1. To describe factors influencing diagnosis and treatment of severe malaria cases.
2. To find association of these factors with diagnosis and treatment of severe malaria.
3. To get a cross sectional picture of the current practice regarding severe malaria, find relationships with identified factors.

4. Procedure of the Research

You have been randomly selected to participate in this study. A total of 156 health workers from 10 health facilities within CP will be make up the total sample size of this study.

Note the following very carefully:

i. Your name is not required in this study.
ii. Every information written on the questionnaire will be kept confidential. Your bosses from the facility, district or province will never have access to any information collected here.
iii. This is not an appraisal, or a court trial. Please do not feel threatened, insecure or uncomfortable. Be at peace and open minded when filling the questionnaire.
iv. This is purely a student's academic requirement, more or less an assignment, to attain a qualification. Kindly completely the questionnaire honestly. However, the research may provide valuable information.
v. Feel free to ask anything you are not clear with while going through the questionnaire.

5. Procedure of taking consent

After you have read though the information sheet, and/or with clarifications from the principal researcher or research assistants, you will be required to give a written consent if you are willing to participate in this study.

The researcher will keep consent form separately from questionnaires and the sign of consent will not be traced back to your answer to survey questionnaires.

The researcher will not note down your name or other personal information details that can identify your answer on questionnaires. Your colleagues or bosses will not see your response in questionnaires because all the information you give to us must be kept confidentially and anonymously and will not be shared or showed in front of anyone.
If you don't want to participate, you don't need to give consents and you don't need to explain anything as a reason.

6. Benefits

The study will not give benefit directly to you, but it will provides baseline information for the province and country to develop appropriate measures in terms of policy etc accordingly.
As your participation is entirely voluntary, nevertheless, the researcher will provide you a good lunch for taking up your lunch hour.

7. Confidentiality

Any information that is linked to you will be kept confidentially. Your names or other identifying information will not be mentioned in the report or summaries of the study. The final report can be available from the principal researcher and the report will not be used with another intension. All data will be kept confidential.

1. Introdaksen

Nem bilong mi Leonard R. Nawara, na wanpela mastas digri sumatin long Chulalongkorn University, long Thailand. Blong mipela long kisim digri bilong mipela, mipela imas mekim wanpela wok painim aut (stadi) na raitim ripot. Mi bin kamapim tingting long mekim stadi bilong mi long pasin bilong hausik wok manmeri, na women ol samting isave stopim, na women ol samting isave kamapim gutpela wok long lukautim bikpela sik malaria namel long ol hausik wok manmeri insait long CP long pasin bilong lukautim ol sikman igat bikpela malaria.

Nem bilong mi: Leonard Rakhuna Nawara (Dr)
Fon namba: +675 71833572
Email edres: leonardnawara@gmail.com

Het tok bilong stadi:
"FACTORS INFLUENCING PRACTICE REGARDING SEVERE MALARIA AMONG HEALTH WORKERS IN CENTRAL PROVINCE, PAPUA NEW GUINEA."
Mi nau amamas long welkamim yu long stap insait long dispel stadi. Yu ken ritim olgeta infomesen istap long pepa na skelim tingting. Sapos yu no klia long sampela samting orait yu ken askim mipela na bai mipela kliarim yu gut.

2. Ol Kosten I Olsem Wonem

Dispela stadi igat kosten we yu yet bai ritim na makim ansa. Olgeta ansa igat bokis pinis na bai yu tikim bokis tasol. Bai yu raitim tasol krismas bilong yu wantaim nem bilong women skul yu bin go long skul dokta, HEO, nes, or CHW.

3. As Tingting bilong Stadi

Ol as tingting bilong dispela wok painim aut emi olsem;

1. Wonem ol samting isave influensim pasin bilong lukautim ol sikman wantaim bikpela sik malaria.
2. Ol luksave long pasin bilong lukautim bikpela sik malaria na tu luksave long women ol samting isave kamap kain pasin.

4. Wei bilong Wokim Stadi

Yu em wanpla namel long 156-pela wok manmeri insait long CP husait bai stap insait long dispela stadi.

Yu imas klia gut olsem:

i. Mipela ino laikim yu raitim nem bilong yu.
ii. Wonem ol ansa yu raitim em bai stadi wokman tasol ikisim pepa bilong yu. Ino inap tru long narapela lain ilukim dispela ol pepa. Ol bis bilong y utu bai ino inap tru long lukim. Igat bikpela tok itambu tru istap. Dispela em ino apreisol o wokim bilong painim asua so plis, noken tru poret long makim ol onest ansa bilong yu.

iii. Dispela ol skul asinmen bilong wan pikinini bilong PNG skul ovasis. Halivim bilong yu long ansarim ol kosten bai bikpela halivim long helpim sumatin long kisim mastas digri bilong em.
iv. Sapos yu no klia long sampela toksave, ino ken poret long askim wokman.

5. Wei bilong Kisim Tok Orait

Bihain long yu ritim ol toksave, na wokman i kliarim yu gut, bai yu mas sainim tok orait pepa long istap insait long dispel stadi. Tok orait pepa em bai stap wantaim wokman. Yu sainim tasol na wokman bai kisim bek. Yu no inap ritim nem bilong yu. Ino inap tru long narapela lain ilukim. Ol bos bilong y utu bai ino inap tru long lukim.

6. Ol Gutpela bilong Stadi

Dispela stadi bai givim givim sampela tingting long provins na kantri tu wantaim long pasin biling lukautim bikpela sik malaria.
Disisen bilong yu long stap insait long stadi em laik bilong yu yet. Mipela bai provaidim gutpela lans bilong yu long tok ten kyu.

7. Tok Hait

Olgeta infomesen mipela kisim em bai mipela haitim tru. Nogat narapela man o meri inap tru long lukim, inap sumatim ipinisim skul.

APPENDIX 4: CONSENT FORM

I have read through the information sheet, or have been verbally informed, and I fully understood the objectives, benefits and importance of this study.

With informed opinion;

1. I agree to take part in this study:

   _____ (Signature only. No names please)

2. I disagree to take part in this study:

   _____(signature)

APPENDIX 5. ETHICAL COMMITTEE APPROVAL LETTER

Government of Papua New Guinea
Medical Research Advisory Committee
National Department of Health

PO Box 807
WAIGANI 131, NCD
Papua New Guinea

Phone: + (675) 301 3685
Fax: + (675) 323 9670
Email: fhombhanje@dwu.ac.pg

Meeting #: 04-2017
DATE: 04/04/2018

Dr Leonard Nawara
Public Health Division
National Department of Health
P.O. Box 807
WAIGANI
NCD

Dear Dr Nawara,

Subject: MRAC Decision on Proposal Reviewed

The Medical Research Advisory Committee (MRAC) of Papua New Guinea has deliberated on your research proposal "**FACTORS INFLUENCING PRACTICE REGARDING SEVERE MALARIA AMONG HEALTH WORKERS IN CENTRAL PROVINCE, PAPUA NEW GUINEA"** on the 19th of February, 2018.

MRAC has given executive approval for your study and assigned **MRAC No: 17.55.**

The MRAC would like to thank you for your submission and look forward to the successful conducting of your study.

Investigators are reminded of approved research to be conducted according to the MRAC guidelines at all times and the importance of keeping relevant authorities including MRAC informed on the progress and outcomes of their study.

Thank you and best wishes,

.....
Ms Manah Dindi
Deputy Chairperson - MRAC

APPENDIX 6: QUESTIONNAIRE

Code number…….

Factors Influencing Practice Regarding Severe Malaria Among Health Workers in National Capital District, Papua New Guinea.

PART 1: MODIFYING VARIABLES

1.1. SOCIO-DEMOGRAPHY

QUESTION	ANSWER
1.1.1. What is your sex?	1.1.1.1. Male: □ 1.1.1.2. Female: □
1.1.2. What was your age at your last birthday?	2.1.2.1 Answer: _____
1.1.3. What is your marital status?	1.1.3.1. □Married 1.1.3.2. □Never married 1.1.3.3. □Divorced/separated 1.1.3.4. □Widowed
1.1.4. What is your religion?	1.1.4.1 □Christianity 1.1.4.2 □Mormon 1.1.4.3. □Jehovah Witness 1.1.4.4. □Islam
1.1.5. Do you go for church services? (Saturdays, Sundays, etc).	1.1.5.1. □Yes 1.1.5.2. □No 1.1.5.2. □Sometimes
1.1.6. Do you hold any social roles/ positions? (church leadership, community group executive, union leadership).	1.1.6.1. □Yes 1.1.6.2. □No 1.1.6.3. □Sometimes
1.1.7. What is your average income per fortnight?	1.1.7.1 □ Less than K500 1.1.7.2 □ Between K500 and K1000 1.1.7.3. □ Between K1000 and K1500 1.1.7.4. □ Above K1500

1.2. PROFESSIONAL VARIABLES

QUESTIONS	ANSWER
1.2.1. What is your profession?	1.2.1.1. □Medical doctor 1.2.1.2. □Nursing officer 1.2.1.3. □HEO 1.2.1.4. □CHW
1.2.2. How many years of clinical work experience do you have?	1.2.2.1. Answer: _____

1.3. KNOWLEDGE REGARDING SEVERE MALARIA (Tick your answer).

QUESTION	**ANSWER**
1.3.1. What is severe malaria? Severe malaria is defined as;	1.3.1.1. □ Presence of danger signs [d] 1.3.1.2. □ Presence of danger signs with +ve RDT/micro 1.3.1.3. □ Malaria caused by plasmodium falciparum 1.3.1.4. □ Malaria caused by mixed infection
1.3.2. Which of the following can be clinical features of severe malaria?	1.3.2.1. □ Coma 1.3.2.2. □ Hypoglycaemia 1.3.3.3. □ Respiratory distress 1.3.4.4. □ None of the above 1.3.5.5. □ All of the above
1.3.3. Do you think RDT can confirm diagnosis of severe malaria?	1.3.3.1. □ Yes If yes, skip question 1.3.4 1.3.3.2. □ No If no, go to 1.3.4
1.3.4. If no to 4.7, why do you think RDT cannot confirm a diagnosis of severe malaria? Because;	1.3.4.1. □ RDT gives false results 1.3.4.2. □ RDT result is complicated to read 1.3.4.3. □ RDT it is not recommended for severe malaria 1.3.4.4. □ Parasite count is low in severe malaria
1.3.5. After applying buffer, how many minutes should you wait before reading a CareStart RDT result?	1.3.5.1. □ 5 minutes 1.3.5.2. □ 10 minutes 1.3.5.3. □ 15 minutes 1.3.5.4. □ 20 minutes
1.3.6. What is the gold standard of malaria diagnosis?	1.3.6.1. □ RDT 1.3.6.2. □ Microscopy 1.3.6.3. □ PCR (genetic analysis) 1.3.6.4. □ All of the above

1.3.7. What is required for microscopy results to be reliable?	1.3.7.1. □ A good microscope 1.3.7.2. □ Good technical skills of microscopist 1.3.7.3. □ Clean slide and good-quality reagents 1.3.7.4. □ All of the above
1.3.8. What should you do if both RDT and microscopy are not available and you suspect a patient has severe malaria?	1.3.8.1. □ Send the patient home to be reviewed later 1.3.8.2. □ Supply mala-1 (AL) and send patient home 1.3.8.3. □ Refer to private pharmacy with prescription 1.3.8.4. □ Refer to higher health facility
1.3.9. What is the current first-line treatment for severe malaria in PNG treatment policy for general population?	1.3.9.1. □ Artemether (IV/IM) * 1.3.9.2. □ Quinine (IV/IM) * 1.3.9.3. □ Artesunate (IV/IM) * 1.3.9.4. □ All of the above
1.3.10. What is the current first-line treatment for severe malaria in PNG treatment policy for pregnant women?	1.3.10.1. □ Artemether (IV/IM) * 1.3.10.2. □ Quinine (IV/IM) * 1.3.10.3. □ Artesunate (IV/IM) * 1.3.10.4. □ All of the above
1.3.11. Do you think there is a second-line treatment for severe malaria in the current policy?	1.3.11.1. □ Yes If yes, go to 1.3.12 1.3.11.2. □ No If no, skip 1.3.12 and go to 1.3.13
1.3.12. If yes to 1.4.11, what is the second-line treatment for severe malaria in the current policy?	1.3.11.1. □ Artemether (IV/IM) * 1.3.11.2. □ Quinine (IV/IM) * 1.3.11.3. □ Artesunate (IV/IM) * 1.3.11.4. □ All of the above
1.3.13. Do you think severe malaria patient should receive oral treatment after receiving artemether / artesunate injection?	1.3.13.1. □ Yes If yes, go to question 1.3.14. 1.3.13.2. □ No If no, go to 1.3.15.
1.3.14. If yes, which drug should be given after a patient receives artemether / artesunate injection?	1.3.14.1. □ Chloroquine tablets 1.3.14.2. □ Fansidar tablets (Sulfadoxine pyrimethamine) 1.3.14.3. □ Mala-1 (Artemether lumefantrine) 1.3.14.4. □ Artemether tablet

1.3.15. Is AL (Mala-1) recommended for pregnant women after they have completed parenteral treatment?	1.3.15.1. □ Yes 1.3.15.2. □ Yes, but not in first trimester of pregnancy 1.3.15.3. □ Don't know

*In PNG, health workers are more used the acronyms "I.M" to mean intramuscular injection, and "I.V" for intravenous injection.

[d] Danger signs in children refers to unable to drink or breastfeed, vomiting, convulsions, lethargic or impaired conscious, neck stiffness, chest indrawing or stridor. Danger signs in adults refers to being very weak or unable to stand, lethargic or impaired conscious, neck stiffness, convulsions, respiratory distress or severe abdominal pain.

PART 2: INDIVIDUAL ATTITUDES AND PERCEPTIONS

ATTITUDE

Section 2.1. Attitude towards clinical practice (Tick your preferred option)**.**

STATEMENT	RESPONSE
2.1.1. Generally, the current practice guidelines regarding severe are confusing and inconvenient. [n]	2.1.1.1. □ Strongly agree 2.1.1.2. □ Agree 2.1.1.3. □ Disagree 2.1.1.4. □ Strongly disagree
2.1.2. In management of severe malaria, practice guidelines are important.	2.1.2.1. □ Strongly agree 2.1.2.2. □ Agree 2.1.2.3. □ Disagree 2.1.2.4. □ Strongly disagree
2.1.3. The current practice guidelines regarding severe malaria are difficult to apply and adapt to my specific practice. [n]	2.1.3.1. □ Strongly agree 2.1.3.2. □ Agree 2.1.3.3. □ Disagree 2.1.3.4. □ Strongly disagree
2.1.4. The current practice guidelines regarding severe malaria improve patient outcomes.	2.1.4.1. □ Strongly agree 2.1.4.2. □ Agree 2.1.4.3. □ Disagree 2.1.4.4. □ Strongly disagree
2.1.5. Generally, I would prefer to continue my routines and habits rather than to change based on practice guidelines. [n]	2.1.5.1. □ Strongly agree 2.1.5.2. □ Agree 2.1.5.3. □ Disagree 2.1.5.4. □ Strongly

	disagree
2.1.6. Guidelines help to standardise care and assure that patients are treated in a consistent way.	2.1.6.1. □ Strongly agree 2.1.6.2. □ Agree 2.1.6.3. □ Disagree 2.1.6.4. □ Strongly disagree
2.1.7. I don't have the time to stay informed about available guidelines on practice regarding severe malaria. [n]	2.1.7.1. □ Strongly agree 2.1.7.2. □ Agree 2.1.7.3. □ Disagree 2.1.7.4. □ Strongly disagree

*Danger signs in children – unable to drink or breastfeed, vomiting, convulsions, lethargic or impaired conscious, neck stiffness, chest indrawing or stridor.
NB: "Practice as stated here includes diagnosis, treatment and follow-up of patients with severe malaria.

Section 2.2: Attitude towards responsiveness.

STATEMENT	RESPONSE
2.2.1. When managing severe malaria patients, it is not important to consider courtesy and sensitivity to potentially embarrassing moments because it is a waste of time. [n]	2.2.1.1. □ Strongly agree 2.2.1.2. □ Agree 2.2.1.3. □ Disagree 2.2.1.4. □ Strongly disagree
2.2.2. Patients or relatives should be allowed to give their views towards what interventions they receive and what they do not receive.	2.2.2.1. □ Strongly agree 2.2.2.2. □ Agree 2.2.2.3. □ Disagree 2.2.2.4. □ Strongly disagree
2.2.3. It is good practice to allow individuals to have the right to preserve confidentiality of their personal health information from health workers. [n]	2.2.3.1. □ Strongly agree 2.2.3.2. □ Agree 2.2.3.3. □ Disagree 2.2.3.4. □ Strongly disagree
2.2.4. Very sick patients should not be kept waiting for longer periods at the health facility unnecessarily.	2.2.4.1. □ Strongly agree 2.2.4.2. □ Agree 2.2.4.3. □ Disagree 2.2.4.4. □ Strongly disagree

2.2.5. Basic amenities, such as clean waiting rooms or adequate beds and food in health facilities are important aspects of care that are often highly valued by the population.	2.2.5.1. ☐ Strongly agree 2.2.5.2. ☐ Agree 2.2.5.3. ☐ Disagree 2.2.5.4. ☐ Strongly disagree
2.2.6. It is a waste of time for clinicians to contribute to social support. [n]	2.2.6.1. ☐ Strongly agree 2.2.6.2. ☐ Agree 2.2.6.3. ☐ Disagree 2.2.6.4. ☐ Strongly disagree
2.2.7. It is good to allow for patients / relatives to select who or which facility they wish to go for healthcare.	2.2.7.1. ☐ Strongly agree 2.2.7.2. ☐ Agree 2.2.7.3. ☐ Disagree 2.2.7.4. ☐ Strongly disagree

PERCEPTIONS

Section 2.3. Perceived Susceptibility (Tick your preferred option)**.**

STATEMENTS	RESPONSES
2.3.1. People from highlands are at higher risk of being affected by severe malaria than people from lowlands.	2.3.1.1. ☐ Strongly agree 2.3.1.2. ☐ Agree 2.3.1.3. ☐ Disagree 2.3.1.4. ☐ Strongly disagree
2.3.2. Children will always get severe malaria if they are infected with malaria even if they are treated prompt. [n]	2.3.2.1. ☐ Strongly agree 2.3.2.2. ☐ Agree 2.3.2.3. ☐ Disagree 2.3.2.4. ☐ Strongly disagree
2.3.3. Pregnant women are more likely to be affected by severe malaria than non-pregnant women.	2.3.3.1. ☐ Strongly agree 2.3.3.2. ☐ Agree 2.3.3.3. ☐ Disagree 2.3.3.4. ☐ Strongly disagree
2.3.4. Every PNGan has partial immunity, thus reduced chances of developing severe malaria. [n]	2.3.4.1. ☐ Strongly agree 2.3.4.2. ☐ Agree 2.3.4.3. ☐ Disagree 2.3.4.4. ☐ Strongly disagree
2.3.5. Europeans coming into PNG have higher chances of dying from severe malaria.	2.1.5.1. ☐ Strongly agree 2.1.5.2. ☐ Agree 2.1.5.3. ☐ Disagree 2.1.5.4. ☐ Strongly disagree

Section 2.4. Perceived Severity (Tick your preferred option)**.**

STATEMENT	RESPONSE
2.4.1. Severe malaria is not a very serious condition.	2.4.1.1. ☐ Strongly agree 2.4.1.2. ☐ Agree 2.4.1.3. ☐ Disagree 2.4.1.4. ☐ Strongly disagree
2.4.2. Severe malaria patients can sometimes get better without treatment.	2.4.2.1. ☐ Strongly agree 2.4.2.2. ☐ Agree 2.4.2.3. ☐ Disagree 2.4.2.4. ☐ Strongly disagree
2.4.3. Complications of severe malaria are dangerous and can result in death.	2.4.3.1. ☐ Strongly agree 2.4.3.2. ☐ Agree 2.4.3.3. ☐ Disagree 2.4.3.4. ☐ Strongly disagree
2.4.4. Risk of death from severe malaria in children and adults is the same.	2.4.4.1. ☐ Strongly agree 2.4.4.2. ☐ Agree 2.4.4.3. ☐ Disagree 2.4.4.4. ☐ Strongly disagree
2.4.5. All patients with severe should be admitted or referred.	2.4.5.1. ☐ Strongly agree 2.4.5.2. ☐ Agree 2.4.5.3. ☐ Disagree 2.4.5.4. ☐ Strongly disagree

Section 2.5. Perceived Barriers (Tick your preferred option)**.**

STATEMENT	RESPONSE
2.5.1. RDT results are very unreliable to diagnose severe malaria.	2.5.1.1. ☐ Strongly agree 2.5.1.2. ☐ Agree 2.5.1.3. ☐ Disagree 2.5.1.4. ☐ Strongly disagree
2.5.2. If there is no microscopy to confirm results, RDT should not be used.	2.5.2.1. ☐ Strongly agree 2.5.2.2. ☐ Agree 2.5.2.3. ☐ Disagree 2.5.2.4. ☐ Strongly disagree
2.5.3. Currently recommended first-line drugs antimalarial drugs (artemether & artesunate) are not very effective to treat severe malaria.	2.5.3.1. ☐ Strongly agree 2.5.3.2. ☐ Agree 2.5.3.3. ☐ Disagree 2.5.3.4. ☐ Strongly disagree
2.5.4. Severe malaria patients do not need prompt attention if there are not enough drugs to treat them.	2.5.4.1. ☐ Strongly agree 2.5.4.2. ☐ Agree 2.5.4.3. ☐ Disagree 2.5.4.4. ☐ Strongly disagree

2.5.5. Severe malaria patients should be sent home if there are no RDT or drugs at the health facility.	2.5.5.1. ☐ Strongly agree 2.5.5.2. ☐ Agree 2.5.5.3. ☐ Disagree 2.5.5.4. ☐ Strongly disagree

Section 2.6. Perceived Benefit (Tick your preferred option)**.**

STATEMENT	RESPONSE
2.6.1. Health workers who perform well in management of severe malaria should be rewarded with bonus.	2.6.1.1. ☐ Strongly agree 2.6.1.2. ☐ Agree 2.6.1.3. ☐ Disagree 2.6.1.4. ☐ Strongly disagree
2.6.2. Health workers who perform well in management of severe malaria do not need any more training.	2.6.2.1. ☐ Strongly agree 2.6.2.2. ☐ Agree 2.6.2.3. ☐ Disagree 2.6.2.4. ☐ Strongly disagree
2.6.3. Health workers who perform well important illnesses such as severe malaria should be appraised for pay increase.	2.6.3.1. ☐ Strongly agree 2.6.3.2. ☐ Agree 2.6.3.3. ☐ Disagree 2.6.3.4. ☐ Strongly disagree
2.6.4. Health workers should safeguard their reputation more than complying to recommended guidelines.	2.6.4.1. ☐ Strongly agree 2.6.4.2. ☐ Agree 2.6.4.3. ☐ Disagree 2.6.4.4. ☐ Strongly disagree
2.6.5. When there is good patient education, the community thinks that the health worker is good.	2.6.5.1. ☐ Strongly agree 2.6.5.2. ☐ Agree 2.6.5.3. ☐ Disagree 2.6.5.4. ☐ Strongly disagree

Section 2.7. Perceived self-efficacy. (Tick your preferred option)**.**

STATEMENT	RESPONSE
2.7.1. I believe that I can distinguish the clinical features of severe malaria from other illnesses.	2.7.1.1. □ Strongly agree 2.7.1.2. □ Agree 2.7.1.3. □ Disagree 2.7.1.4. □ Strongly disagree
2.7.2. I know how to perform a malaria RDT correctly.	2.7.2.1. □ Strongly agree 2.7.2.2. □ Agree 2.7.2.3. □ Disagree 2.7.2.4. □ Strongly disagree
2.7.3. I know how to implement the national treatment guidelines on severe malaria sufficiently enough.	2.7.3.1. □ Strongly agree 2.7.3.2. □ Agree 2.7.3.3. □ Disagree 2.7.3.4. □ Strongly disagree
2.7.4. I believe that I can overcome barriers to severe malaria cases based on national treatment guidelines.	2.7.4.1. □ Strongly agree 2.7.4.2. □ Agree 2.7.4.3. □ Disagree 2.7.4.4. □ Strongly disagree
2.7.5. I am sure about how to measure outcomes of clinical care of a patient with severe malaria.	2.7.5.1. □ Strongly agree 2.7.5.2. □ Agree 2.7.5.3. □ Disagree 2.7.5.4. □ Strongly disagree

PART 3: CUES AND PRACTICE REGARDING SEVERE MALARIA

QUESTION	ANSWER
3.1. Have you attended any training (in-house or external) on IMCI, national treatment policy, or any other training covering malaria treatment guidelines in the last 6 months?	3.1.1. □ Yes If yes, go to Q3.2 3.1.2. □ No If no, skip Q3.2
3.2. How do you diagnose severe malaria patients in your practice? By;	3.2.1. □ Strong clinical suspicion 3.2.2. □ Patient having very high fever 3.2.3. □ By clinical suspicion & +ve RDT 3.2.4. □ Clinical suspicion and 2nd opinion
3.3. Is malaria microscopy done in your health facility at the moment?	3.3.1. □ Yes If yes, go to Q3.4 3.3.2. □ No If no, skip Q3.4
3.4. If yes, is it functional every time you need it?	3.4.1. □ Yes 3.4.2. □ No 3.4.3. □ Not sure
3.5. Is there constant supply of RDT at the facility?	3.5.1. □ Yes 3.5.2. □ No 3.5.3. □ Not sure

3.6. Do you perform RDT on patients suspected of having severe malaria?	3.6.1. □ Yes 3.6.2. □ No 3.6.3. □ Sometimes
3.7. Do you have access to the malaria treatment policy? (chart, booklet, standard treatment books)	3.7.1. □ Yes If yes, go to Q3.8 3.7.2. □ No If no, skip Q3.8
3.8. If yes, do you find it useful?	3.8.1. □ Yes 3.8.2. □ No 3.8.3. □ Sometimes
3.9. Is there constant supply of artesunate and artemether injections at the facility?	3.9.1. □ Yes 3.9.2. □ No 3.9.3. □ Not sure
3.10. Have you administered artesunate injection (IV/IM) to patients?	3.10.1. □ Yes 3.10.2. □ No 3.10.3 □ Not sure
3.11. Have you administered artesunate suppository (PR) to patients?	3.11.1. □ Yes 3.11.2. □ No 3.11.3. □ Not sure
3.12. What type of patients do you give artemether injection (IM) to?	3.12.1. □ RDT positive patients 3.12.2. □ RDT +ve & cannot take oral med 3.12.3. □ RDT negative 3.12.4. □ RDT negative & clinical suspicion
3.13. Do you give artemether injection (IM) stat dose only to patients?	3.13.1. □ Yes If yes, go Q3.16 3.13.2. □ No If no, skip Q3.16 3.13.3. □ Sometimes
3.14. If yes, why do you give artemether stat dose only to patients? Because;	3.14.1. □ it is standard practice 3.14.2. □ it cures malaria 3.14.3. □ it makes patients happy 3.14.4. □ it covers other infections as well
3.15. Do you supply mala-1 to patients after they have received artemether/artesunate injection?	3.15.1. □ Yes If yes, skip Q3.16 3.15.2. □ No If no, go to Q3.16
3.16. If no, why don't you supply mala-1 to patients have received artemether/artesunate injection? Because;	3.16.1. □ it is waste of medicine 3.16.2. □ it is not recommended 3.16.3. □ artemether cures malaria fully 3.16.4. □ patients don't like it

3.17. Do you have supervision from a senior staff or someone from the provincial or national level regarding diagnosis and treatment of severe malaria?	3.17.1. ☐ Yes If yes, go Q3.18 3.17.2. ☐ No If no, skip Q3.18
3.18. If yes, does supervision motivate you to perform better?	3.18.1. ☐ Yes 3.18.2. ☐ No 3.18.3. ☐ Not really
3.19. Is data (statistics) on <u>severe malaria</u> or malaria from this facility shared with staff? By someone within the facility or from provincial/national level).	3.19.1. ☐ Yes If yes, go Q3.20 3.19.2. ☐ No If no, skip Q3.20 3.19.3. ☐ Sometimes
3.20. If yes, does data sharing motivate you to improve in your practice?	3.20.1. ☐ Yes 3.20.2. ☐ No 3.20.3. ☐ Not really
3.21. Do you advise patients treated as <u>severe malaria</u> to come for follow-up (within 14 days)?	3.21.1. ☐ Yes If yes, skip Q3.22. 3.21.2. ☐ No If no, go to Q3.22. 3.21.3. ☐ Sometimes
3.22. If your answer to Q21 is 'no', why <u>don't</u> you advise patients treated as <u>severe malaria</u> to come for follow-up? Because;	3.12.1. ☐ it is not necessary 3.22.2. ☐ we have a high workload 3.22.3. ☐ usually patients don't get relapse 3.22.4. ☐ patients will not come back
3.23. If your answer to Q21 is 'yes', why <u>do</u> you advise patients treated as <u>severe malaria</u> to come for follow-up? Because;	3.23.1. ☐ to check for fever 3.23.2. ☐ to check for other symptoms 3.23.3. ☐ to re-check RDT 3.23.4. ☐ to refer for microscopy

VITA

Dr Leonard Nawara is the Medical Officer for National Malaria Control Program at Ministry of Health in Papua New Guinea, a position he started on since April 2015.

Dr Nawara was born in Mendi, Southern Highlands, Papua New Guinea (PNG) on 13 June 1985. He completed his secondary education at Ialibu Secondary School, Southern Highlands, and from University of Papua New Guinea with a Bachelor Medicine & Bachelor of Surgery (MBBS) in 2009.

From 2010 to 2011 he did his internship at the then Goroka General Hospital in PNG. From January to May 2012 he was the Paediatric Registrar working alone at then Wabag General Hospital. In June 2012 to August 2013 he left for a stint at Exxon Mobil's PNG Liquified Natural Gas Project to work as a Site Medical Officer in a number of sites around the project areas.

In September 2013 Dr Nawara returned to public service to work with Western Highlands Provincial Health Authority (WHPHA) as a Paediatric Registrar. While being there he was trained in WHO's Paediatric Care and the then newly introduced care of malnourished children using ready-made food supplied by UNICEF. He was also in the WHPHA Measles Task Force to response to a measles outbreak in 2014.

In 2015 Dr Nawara was recruited as the program's first medical officer for National Malaria Control Program after the position was newly created. While working their he initiated the program's first therapeutic efficacy study to be done on the country's first-line antimalarial drug, artemether-lumefantrine.

From September 2017 to July 2019 he attended the College of Public Health Sciences (CPHS), Chulalongkorn University, Bangkok, Thailand and completed a Master of Public Health degree under Thai Government Scholarship (TICA). He did his research on factors influencing management of severe management in Central Province, PNG. It was while being a student that this biography was drafted.