School of Pharmacy

Public Sector Management of Essential Medicines: An Evaluation of the System in Papua New Guinea

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Isaac B Joshua ……..

Date 20 September 2013

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Abbreviations

PNG	Papua New Guinea
MSH	Management Sciences of Health
EM	Essential Medicines
WTO	World Trade Organization
TRIPS	Trade Related Aspects of Intellectual Property Rights
UN	United Nation
PICs	Pacific Island Countries
PM	Pharmaceutical Management
MDC	Medical and Dental Catalogue
NDP	National Drug Policy
RDU	Rational Drug Use
WHO	World Health Organization
INRUD	International network on Rational Use of Drugs
GDP	Gross Domestic Product
PNGK	Papua New Guinea Kina
DT	Dental Therapist
RDO	Resident Dental Officer
DO	Dental Officer
HEOs	Health Extension Officers
RHEOs	Resident Health Extension Officers
NOs	Nursing Officers
MOs	Medical Officers
RMO	Resident Medical Officer
SMO	Specialist Medical Officer

SSMO	Senior Specialist Medical Officer
STGs	Standard Treatment Guidelines
LHC	Losuia Health Centre
APH	Alotau Provincial Hospital
USA	United States of America
EDL	Essential Drug List
EML	Essential Medicines List
PMGH	Port Moresby General Hospital
IM	Intra-Muscular Injection
IV	Intravenous Injection
NCD	National Capital District
P	Probability
CHWs	Community Health Workers
CQ	Chloroquine
AQ	Amodiaquine
SP	Sulphadoxine-pyrimethamine
UTI	Urinary Tract Infection
URTI	Upper Respiratory Tract Infection
COPD	Chronic Obstructive Pulmonary Disease
AMH	Australian Medicines Handbook
GPARC	Global Plan for Artemisinin Resistance Containment
HCOF	Health Centre Order Form
TB	Tuberculosis
CNS	Central Nervous System
eTG	Therapeutic Guidelines of Australia
PNGHSDP	Papua New Guinea Health Services Delivery Profile

Abstract

Most leading causes of death and disability in developing countries can be prevented, treated, or at least alleviated with cost-effective essential medicines. Despite this fact, hundreds of millions of people do not have regular access to essential medicines. Many of those who do are either given the wrong drug treatment, received too little medicines for their illness, or do not use the medicines correctly. The issue of people having access to essential medicines has been a continuing problem in Papua New Guinea (PNG) for the last 10-15 years.

Objective: To evaluate the system of management of essential medicines in selected public sector healthcare facilities in PNG using the health department standard treatment guidelines and essential medicines list as the benchmark, the management of essential medicines was evaluated to determine the level of utilisation/appropriateness by prescribers' managing them.

Study design: A prospective study was carried out at Losuia Health Centre (LHC), Alotau Provincial Hospital (APH), and Port Moresby General Hospital (PMGH) in PNG. At each setting >300 consecutive prescriptions were evaluated in 2010. This involved the recording of drug prescribing orders from written prescriptions, the diagnosis made by the prescriber obtained from the health book and where necessary by patient interviews. Patients who gave consent to participate in the study were interviewed. The appropriateness of drug prescribing was evaluated with respect to the relevant PNG Health Department standard treatment guidelines and essential drug list. The range of drugs used for treating selected diseases as stated in the Standard Treatment Guidelines (STGs) and the relevant drugs available for those diseases were extracted from the Medical and Dental Catalogue (MDC, 2002) compiled from the extracted data and analysed for their consistencies. The prescribing data was evaluated by comparing the profiles of patients against various independent variables (including pharmacy location, gender, age group and prescriber category) using chi-squared statistics unless otherwise specified. In all analyses, a P-value <0.05 was taken to indicate a statistically significant association. The overall prescribing quality was evaluated and additional analyses were performed on antibiotics and antimalarial drugs.

Results: There were 1090 patients (748 adults; 341 children) enrolled in the study with 356 at LHC, 318 at APH and 416 at PMGH (Table 3.1). A total of 2495 medicines were

prescribed. The most common (Table 3.4) were amoxicillin products (14.2%), paracetamol (13.8%), artemether/artesunate (7.7%) and chloroquine (6.5%). The average number of drugs prescribed per patient (Table 3.2) was 2.3 (range: 1 to 7). The most common diseases treated (Table 3.3) were malaria (23.2%), acute soft tissue injuries (10.4%), anaemia (8.9%), respiratory problems (8.7%), and cough (5.9%). There was a low level of chronic diseases reported in the samples. Most of the drug prescribing at LHC, which is a rural health centre, was undertaken by Community Health Workers (31.5%) and Nursing Officers (55.1%). At APH and PMGH, which are urban hospitals, the drug prescribing was mostly undertaken by Medical Officers and Specialist Medical Officers. There were statistically significant differences observed for the level of inappropriate prescribing by prescriber category on drug selection ($P < 0.0001$), drug dosage ($P< 0.0001$), and drug duration ($P< 0.0001$). When prescribers were grouped as non-medical and medical at each location, there was also a significant difference ($P<0.0001$) between prescriber categories, dependent on location. The non-medical prescribers made from 12.2-19.5% errors (inappropriate drug prescribing) mainly in drug dosage. At APH and PMGH, inappropriate drug selection was at levels of 31.0% and 27.7%, respectively. It is notable that medical doctors performed most of the drug prescribing in these centres. There were very few patients for whom prescribing was performed by Dental Officers, Dental Therapists or Resident Dental Officers.

The overall prevalence of inappropriate drug prescribing across all locations, based on the guideline parameters of drug selection, drug dosage, drug frequency and drug duration combinations, was 33.3%, ranging from 30.4% to 37.9% for the different centres. Children received a higher number of inappropriate doses than adults and these were significantly different across the locations ($P<0.0001$). The overall inappropriate prescribing was 33.4% in adults and 39.9% in children the difference mainly arising from inappropriate drug dosage.

Overall, 58.4% of patients were prescribed antibiotics at their consultation and a small proportion (9.3%) an injection. The prescribing appropriateness of antibiotics showed that approximately one quarter were inappropriate drug selections. These were made up of 23.8% when antibiotics should not have been selected for the diagnosis and 24.6% where an antibiotic type was indicated in the guidelines but the one selected was not recommended. The overall inappropriate prescribing of antibiotics based upon any

of the four categories (selection, dosage, frequency, and duration) by location indicated a significant difference in the three locations with 44.4% at LHC and 38.1% at APH contrasting with 29.9% at PMGH.

These were 32.8% (358/1090) patients who were prescribed drugs that received an antimalarial drug. The overall inappropriate prescribing of antimalarial drugs was 22.7% at LHC, 59.4% at APH and 63.6% at PMGH. There were very high levels of inappropriate prescribing of antimalarial drugs which reached 79% for children at APH. The overall inappropriate prescribing of antimalarial drugs by different prescriber categories range from 30.3%-75.0% and the high levels were errors incurred by Medical Officers (72.6%) and Health Extension Officers (75.0%). Approximately, 86.5% of all drugs prescribed were supplied from the dispensaries resulting in 13.5% where there was either no supply, or over-or under-supply.

An analysis of concordance of the STGs with the MDC for ten diseases states showed marked inconsistencies especially in chronic diseases. Notably many drugs were listed in the MDC but not included in the STGs. These often reflected deficiencies in the STGs. This was particularly notable in the management of asthma, hypertension, type 2 diabetes and psychosis.

Conclusion: This is the first study to evaluate the level of management of essential medicines used by prescribers in PNG. As found in this study, the level of inappropriate prescribing was as high as 53.8% in the selected locations in PNG which is of great concern with respect to the quality of PNG health care delivery and needs to be addressed by government authorities. The poor ability of non-medical prescribers to determine appropriate doses in children and the inappropriate selection of drugs by the medical prescribers not adhering to the guidelines was of great concern. The interventions to address the inappropriate levels of prescribing need to be carefully considered prior to implementation. These should include reviews of the prescribing guidelines and their alignment with the MDC (essential medicines list). Other appropriate interventions such as review/upgrade of the guidelines, supervision/oversight of compliance to guidelines, and/or publication of ongoing supervision/audit oversight reports need to occur to address the underlying causes.

1.0 INTRODUCTION

Most leading causes of death and disability in developing countries can be prevented, treated, or at least alleviated with cost-effective essential medicines [1]. Despite this fact, hundreds of millions of people still do not have regular access to essential medicines. Many of those who do have access are either given the wrong drug treatment, received too little medicines for their illness, or do not use the medicine correctly. The issue of access to essential medicines has been a continuing problem in PNG for the last 10-15 years [2].

1.1 Management of essential medicines

Access to quality essential medicines is the right of every patient [3, 4]. Essential medicines save lives and improve health when they are available, should be affordable, of assured quality and properly used [5]. Lack of access to essential medicines remains one of the most serious global public health problems [6]. Although considerable progress in terms of access to essential medicines has been made in the last twenty-five years since the introduction of the essential medicines concept, not all people have benefited equally from improvements in the provision of health care services, nor from access to low cost, effective treatments with essential medicines [6]. Improving access to essential medicines is perhaps the most complex challenge for all involved in the public, private and non-government organization sectors in the field of medicines supply. The World Health Organization (WHO) [6] has formulated a four-part framework (Figure 1.1) to identify the core elements influencing access to essential medicines and the main pharmaceutical management functions (Figure 1.2) that ensures effective management of essential medicines. This has also been adopted by WHO key partners worldwide.

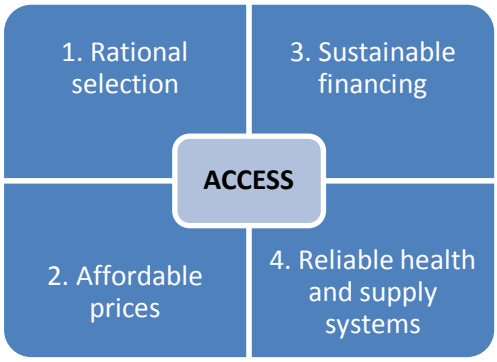

Fig: 1.1. A framework for collective action in improving access to essential medicines [6]

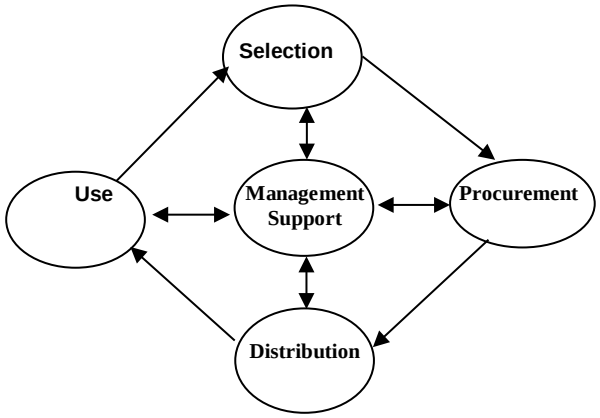

Fig: 1.2. Drug management cycle [1]

1.1.1 Elements that influence access to essential medicines

According to WHO [6], the following core elements have to be established to influence access to essential medicines. Firstly, rational selection and use of essential medicines could be achieved by; developing national treatment guidelines based on the best available evidence concerning efficacy, safety, quality, and cost-effectiveness; develop a national list of essential medicines based on national treatment guidelines; and use a national list of essential medicines for procurement, reimbursement, training, donations and supervision. Secondly, affordable prices are achieved by; use of available and impartial price information; allow price competition in the local market; promote bulk procurement; implement generics policies; negotiate equitable pricing for newer essential medicines for priority diseases; undertake price negotiation for newly registered essential medicines; eliminate duties, tariffs and taxes on essential medicines; reduce mark-ups through more efficient distribution and dispensing systems; encourage local production of essential medicines of assured quality when appropriate and feasible; and include WTO/TRIPS compatible safeguards into national legislation. Thirdly, sustainable financing is achieved by; increase public funding for health, including for essential medicines; reduce out-of-pocket spending, especially by the poor; expand health insurance through national, local, and employer schemes; target external funding - grants, loans, donations – at specific diseases with high public health impact; and explore other financing mechanisms, such as debt-relief and solidarity funds. Fourthly, reliable supply systems are achieved by; integration of medicines in health sector development; create efficient public-private-non-government organisation

mix approaches in supply delivery; assure quality of medicines through regulatory control; explore various purchasing schemes: procurement co-operatives; and include traditional medicines in the health care provision. These elements formed the core of promoting access to essential medicines and by having them available, they will make way for the establishment of the pharmaceutical management functions to ensure effective management of essential medicines.

1.1.2 The pharmaceutical management framework

According to MSH [1], the pharmaceutical management (PM) framework (Figure 1.2) provides the supporting structure for improving access to essential medicines. PM framework involves four basic functions of selection, procurement, distribution, and use. In selection, the common health problems are reviewed, treatments of choice are identified, individual medicines and dosage forms are chosen, and medicines are decided to be available at each level of a healthcare system. In procurement, the medicine requirement are quantified, procurement methods are selected, tenders are managed, contract terms are established, quality of pharmaceuticals are assured, and ensuring adherence to the terms of contract. Distribution involves clearing customs, stock control, stores management, and delivery to drug depots and health facilities. Use involved diagnosing, prescribing, dispensing, and proper consumption by the patient. Each function builds on the previous function and leads logically to the next. A breakdown in one of the functions will lead to failure of the whole PM process. At the center of the PM framework is a core of management support systems comprising of organization, financing and sustainability, information management, and human resources management. These management support systems provide support to the four functions to ensure that essential medicines are managed effectively to enable the population to have full access to essential medicines.

1.1.3 Definition of essential medicines

WHO [6] defined essential medicines as those that satisfy the priority health care needs of the population. They are selected based on the public health needs, evidence of efficacy and safety, and comparative cost-effectiveness. Essential medicines are supposed to be available at all times in adequate amounts, in the appropriate dosage forms, with assured quality and adequate information, and at a price the individual and

the community can afford [7]. The implementation of the concept of essential medicines is intended to be flexible and adaptable to many different situations; exactly which medicines are regarded as essential remains a national responsibility [6].

Reported by Hogerzeil [8], the initial concept of essential medicines was launched in 1977 with the publication of the first World Health Organization's Model List of Essential Medicines. Since then the list has been revised every two years. Both its contents and the process by which it is updated are intended as a model for developing countries and seen as a breakthrough in international public health.

1.1.4 Access to essential medicines in developing countries

The definition of access to essential medicines incorporated the WHO definition that provided the basis for the Millennium Development Goals indicator used to assess access: the proportion of population with access to affordable, essential drugs on a sustainable basis is the percentage of the population who have access to a minimum list of 20 essential medicines, which are continuously available and affordable at a health facility or medicines outlet, within one hour's walk from the patients' home [9].

Stated in the UN Millennium Project [10], along with skilled and dedicated healthcare providers, medicines are the most significant means that society possesses to prevent, alleviate, and cure disease. Most illnesses, especially infectious diseases, are either preventable or to some extent treatable with a relatively small number of medicines. Combined with appropriate public health interventions, appropriately prescribed essential medicines and vaccines could, in principle, massively reduce the impact of disease on communities. Despite this fact, a large proportion of the world's population today still has either only limited access to appropriate essential medicines or no access at all. The consequences of this inadequacy include an enormous loss of life from preventable or treatable diseases (such as tuberculosis, pneumonia, acute respiratory infections, malaria, diabetes, and hypertension) and significant human suffering, particularly among the poor and marginalized populations of the world. The lack of access to life-saving and health-supporting medicines for more than 2 billion poor people stands as a direct contradiction to the fundamental principle of health as a

human right. Women and children make up the majority of the poor, and their low status in many societies often means that they have even less access to medicines.

Increasing access to essential medicines in developing countries, especially for the poor, offers many challenges. These can be crystallized into two main areas [10]: firstly, how to increase access to affordable existing medicines in resource-poor countries settings by improving the selection and use of essential medicines, taking steps to ensure affordable prices, increasing sustainable financing, and strengthening reliable supply systems, secondly, the issue of how to find new ways to promote the development of new medicines and vaccines to treat diseases of poverty.

WHO estimates that a third of the world's population lacks access to the most basic essential medicines, while in the poorest parts of Africa and Asia this figure climbs to one-half [11, 12]. WHO has also estimated that, in Africa and Southeast Asia, prompt diagnosis and treatment with appropriate medicines could save approximately 4 million lives annually [13]. It is often the poorest who are paying the highest out-of-pocket expenses for medicines because the public sector in developing countries is unable to provide affordable medicines reliably.

Medicines and other pharmaceuticals constitute up to 40% of the health care budget in developing countries, yet large proportions of the population frequently lack access to even the most basic essential medicines [14].

A study by Seoane-Vazquez and Rodriguez-Monguio [15] on access to essential drugs in Guyana found major barriers to medicines access such as: lack of national drug policy and regulation, and limited role of the regulatory authority; inefficient drug selection and irrational drug use; insufficient financial resources and lack of drug pricing policy; inefficient planning and managing public supply system; deficient epidemiological and information systems; and inadequate infrastructures and human resources shortage. Improving drug access in Guyana requires the strengthening of the country's public health functions and the implementation of a national drug policy and pricing policy, streamlining the drug financing, procurement, and planning and managing drug supply; and adequate infrastructures and human resources. This study shows how access to essential medicines in some developing countries is very poor.

1.1.5 Access to essential medicines in PNG

PNG like other developing countries faces similar problems of poor access to essential medicines by many of its population. Most of the population (87%) live in the rural areas with only 13% having access to good healthcare (hospitals). Access to essential medicines in PNG has been a continuing problem [2]. Securing essential drugs has historically been a major problem and availability of basic essential medical supplies in health centres rarely surpassed 60% between 1999 and 2010 which means health facilities typically go without drugs for up to half the year [16].

Most of the rural healthcare facilities (aid-posts and health centres) in PNG are staff by community health workers, nurses and health extension officers. These cadres of health workers may have limited knowledge and skills in drug management. As found in the study by Harris [17] in Liberia, health providers (prescribers and dispensers) demonstrated a lack of basic skills and knowledge in pharmaceutical management.

The WHO with its other partners report continued problems in maintaining the supply of essential medicines through to the clinics and aid posts in PNG and other Pacific Island Countries (PICs) [18-24]. This problem is even more pronounced in the rural and remote areas of PICs [25]. The workforce responsible for maintaining the medicines supply system in PICs is made up of nurses, midwives, health extension officers, nurse aids and other health personnel at the primary healthcare level (Level 1), pharmacy supply health personnel at the provincial level (Level 2) and pharmacists and stores managers at the national level (Level 3) [24, 25].

The study by Brown et al. [25] provided insights into learning approaches on student learning within PICs. The themes generated by this review will be used to develop a practical set of principles to guide educators and health personnel involved in developing and teaching curriculum for South Pacific pharmaceutical health personnel to improve management of essential medicines at the rural healthcare facilities in PICs.

There has been a lack of studies on drug use in PNG. However a few related studies are outlined below:

A study by Lauwo and Kiyingi [26] conducted in a village community found; there were numerous instances of inappropriate self-medication, poor compliance and the use of drugs kept beyond their expiry dates. Interventions suggested to improve drug use are: appropriate prescribing and dispensing can help to make the use of drugs more rational, and a great need to educate and motivate the general public to apply the principles of drug use.

The study by Lauwo et al. [27] on pre-packaging antimalarial drugs and counseling on compliance with malaria treatment at PMGH adult outpatient department found that a simple pre-packaging system and proper counseling could improve compliance with antimalarial drug treatment.

The study by Joshua and Sunderland [28] evaluating an intervention program on antimalarial medications for children attending urban clinics in NCD, PNG found that there was a statistically significant improvement in patient outcomes from 57.9% to 92.3% reported as cured following the intervention program. Hence, the simple intervention program in influencing patient carers' understanding on the appropriate and effective use of medications led to a marked improvement in patient outcomes.

These simple educational programs suggested in the above mentioned or other studies [29, 30] on drug use should be integrated into the workshops/in-service training programs planned for those rural health workers whether in PNG or other PICs. In the long term, this should assist them in improving their management skills in managing essential medicines effectively and ultimately should lead to improving access to essential medicines.

1.2 Prescribing of essential medicines

Prescribing medicines is a fundamental component of the care of patients, and optimisation of drug prescribing has become an important public-health issue worldwide [31]. Most encounters between patients and family doctors or physicians end with the issuing of a prescription which makes prescribing as one of the doctor's most important duties [32]. For most doctors, drug therapy is the main tool that they have for influencing

the health of their patients [33]. Therefore, drug prescribing is now an important professional responsibility and a major activity for medical doctors in medical practice.

1.2.1 Appropriate prescribing

Appropriate prescribing is embodied in the concept of Rational Drug Use (RDU), as defined by the World Health Organization (WHO) and requires that patients receive prescribed medications appropriate to their clinical needs, in doses that meet their own requirements, for an adequate period of time, and at an affordable cost to them and their community [34]. This topic has recently been reviewed by Holloway [29] and many primary care based studies carried out over the period 1990 and 2006 have been summarised [35]. Drugs should only be prescribed when they are necessary, and in all cases the benefit of administering the medicine should be considered in relation to the risks involved.

The guide to good prescribing by WHO [36] and extended in practical prescribing by Reynolds [37] and appropriate prescribing of medications by Pollock et al. [38] provides the following steps to assist and remind prescribers of the rational/appropriate approach to drug prescribing: Firstly, on defining the patient's problem;-whenever possible, making the right diagnosis is based on integrating many pieces of information: the complaint as described by the patient; a detailed history; physical examination; laboratory tests; and X-rays and other investigations. This will help in rational prescribing, always bearing in mind that diseases are evolutionary processes. Secondly, on specifying the therapeutic objective;-doctors must clearly state their therapeutic objectives based on the pathophysiology underlying the clinical situation. Very often physicians must select more than one therapeutic goal for each patient. Thirdly, in selecting the therapeutic strategies;-the selected strategy should be agreed with the patient; this agreement on outcome, and how it may be achieved, is termed concordance. The selected treatment can be non-pharmacological and/or pharmacological; it also needs to take into account the total cost of all therapeutic options. The selection process must consider benefit/risk/cost information. This step is based on evidence about maximal clinical benefits of the drug for a given indication (efficacy) with the minimum production of adverse effects (safety). It must be remembered that each drug has adverse effects and it is estimated that up to 10% of hospital admissions in industrialized countries are due

to adverse effects. Not all drug-induced injury can be prevented but much of it is caused by inappropriate selection of drugs. In cost comparisons between drugs, the cost of the total treatment and not only the unit cost of the drug must be considered. Regarding verifying the suitability of the chosen pharmaceutical treatment for each patient;-the prescriber must check whether the active substance chosen, its dosage form, standard dosage schedule, and standard duration of treatment are suitable for each patient. Drug treatment should be individualized to the needs of each patient. Finally, consider drug cost when prescribing and use of computers and other tools to reduce prescribing errors.

1.2.2 Inappropriate drug prescribing

Inappropriate drug prescribing is a global healthcare problem [39-45]. Inappropriate drug prescribing habits can lead to ineffective and unsafe treatment, exacerbation or prolongation of illness, distress and harm to the patient, and higher cost. There is no doubt that patients are becoming ill and some are dying as a result of inappropriate drug prescribing and a substantial proportion of that is undoubtedly avoidable [46]. Prescribing errors are common [47, 48]. Research shows that due to inappropriate prescribing, Americans are taking medications that may not work or may be inappropriate for their mental health problems [49].

Factors that influence it include: failure to prescribe in accordance with clinical guidelines, lack of knowledge and skills, un-restricted availability of medicines, overworked health personnel, out of date or lack of independent information, inappropriate self-medication often of prescription-only medicines, overuse of injections when oral formulations would be more appropriate, inappropriate use of antimicrobials, and poly-pharmacy [34, 40, 50]. In addition, lack of medicines in stock in the dispensary may cause inappropriate prescribing [51]. Mounting evidence supports the WHO contention that drugs are frequently not used to their full potential, nor according to generally accepted criteria [35, 50, 52].

To assist in reducing the incidence of inappropriate drug prescribing, the following interventions are recommended [29, 34, 40, 50, 53]; a mandated multi-disciplinary national body to coordinate medicine use policies, up to date clinical guidelines, professional

supervision, audit and feedback, drug and therapeutics committees in districts and hospitals, continuing in-service medical education as a licensure requirement, essential medicines list based on current guidelines, availability of independent information on medicines, public education about medicines, sufficient government expenditure and processes to ensure availability of medicines, appropriate staff, appropriate and enforced regulation, avoidance of perverse financial incentives, and problem-based pharmacotherapy training in undergraduate curricula.

1.2.3 Definition of drug prescribing

A prescription is a written instruction from a prescriber to a dispenser. The prescriber is not always a doctor but especially in a developing country, it can be a paramedical worker such as a medical assistant, a midwife or a nurse. The dispenser is not always a pharmacist, but can be a pharmacy technician, an assistant or a nurse. Every country has its own standards for the minimum information required for a prescription, and its own laws and regulations to define which drugs require a prescription and who is entitled to write it [54, 55].

The following guidelines will help to ensure that prescriptions are correctly interpreted and leave no doubt about the intention of the prescriber. The guidelines are relevant for primary care prescribing; they may, however, be adapted for use in hospitals or other specialist units. The most important requirement is that the prescription be clear. It should be legible and indicate precisely what should be given. The local language is preferred [54, 55].

1.2.3.1 The prescription form

The following details should be shown on the prescription form [54, 55]: Firstly, the prescriber‘s name, address, and telephone number:- this will allow either the patient or the dispenser to contact the prescriber for any clarification or potential problem with the prescription. Secondly, the date of the prescription:- in many countries, the validity of a prescription has no time limit, but in some countries, pharmacists do not dispense drugs on prescriptions older than 3–6 months. Thirdly, the name, form, and strength of the drug:- the International Non-proprietary name (generic) of the drug should always be

used. If there is a specific reason to prescribe a special brand, the trade name can be added. Generic substitution is allowed in some countries.

1.2.3.2 Prescription writing

As the prescription is the communication link between the prescriber, the pharmacist (or dispenser), and the patient, it is vital to the successful management of the presenting medical condition. Giving information, instructions, and warnings is important to ensure patient adherence (compliance) with drug treatment. Monitoring the treatment involve evaluating the follow-up on the outcome of treatment and allows the stopping of it (if the patient‘s problem is solved) or its’ reformulation when necessary. This step gives rise to important information about the effects of drugs, contributing to the building up of the body of knowledge of pharmacovigilance [56] which is needed to promote the rational use of drugs [54, 55].

1.3 Papua New Guinea (PNG) background

PNG (Figure 1.3) is the largest nation in the Pacific and is classified as a low middle-income country with 2,084 US$ GDP per capita [57]. The leading health problems continue to be communicable diseases, malaria, tuberculosis, diarrhoeal diseases, and acute respiratory disease as major causes of morbidity and mortality [57]. The PNG population (2007) was 6.4 million and 87% live in the rural areas [57, 58]. Life expectancy at birth (2007) was 60.7 years and the total expenditure on health as a percentage of GDP (2005) was 4.2% [57]. General government expenditure on health as a percentage of general government expenditure (2006) was 7.3% which compared to other Pacific Island countries such as Fiji = 4.1%, Solomon Islands = 4.3%, and Vanuatu = 4.3% [59]. PNG total spending on medical supplies was K77.4 million in 2005 (DOH. 2008) (1PNGK = 0.44US$). This amounts to a public per capita spending of 5.9K. GDP in 2006 was K16.17 billion rating medical supplies (mainly drugs) purchases as 0.48% of GDP [60].

Fig 1.3 Map of PNG [61]

1.4 PNG Government support for RDU including appropriate prescribing

PNG has a social security based health system where all PNG citizens have access to healthcare at the primary and secondary levels for a very affordable consultation fee. It is possible for a patient to access the system at the primary level (aid-posts, local health centres, district health centres/hospitals) where they would consult a community health worker, nurse or health extension officer. Provincial hospitals and Port Moresby General Hospital employ doctors and consultations are usually with doctors, although nurses also consult in a few cases at these hospitals.

Certain medicines are available at all levels of the health system and would be dispensed mainly by community health workers at aid-posts. At local and district health centres, medicines would usually be dispensed by community health workers and nurses. Hospitals employ pharmacy technicians and pharmacists to dispense medicines and provide some additional pharmaceutical services.

There is a scarcity of data available with regard to drug prescribing in PNG. In addition, access to essential medicines in PNG has been a continuing problem [2, 62]. In conformity with WHO initiatives regarding RDU, the PNG government approved its first ever National Drug Policy (NDP) in 1998 [63] with the main objective to “improve the health of the people by preventing and treating diseases through the availability and rational use of safe, effective, good quality and affordable drugs”. This policy provides for regulated

importation and control over all drugs and medical supplies through registration and monitoring. In line with the NDP, the government in September 1999, approved a Medicines and Cosmetic Act [64], which among its responsibilities, was to control the registration of all drugs used in PNG.

On the policy side, PNG has a National Health Plan 2001-2010 [65] and a National Drug Policy [63]. On the regulation side, PNG has the Medicines and Cosmetic Act [64] which included the establishment of the Pharmacy Board in 2000, and the current Medical and Dental Catalogue [66] which is the Essential Medicines List. In addition, PNG has developed and distributed a range of Health Department guidelines relevant to a range of medical and surgical disciplines and used in this study as stated below:

- The Manual of Family Planning for Doctors, HEOs and Nurses in PNG [67].
- Standard Management of Sexually Transmitted Infections and Genital Conditions in PNG. A Manual for Health Workers in PNG [68].
- Standard Treatment Guidelines for Children in PNG [69].
- Standard Treatment for Common illnesses of Adults in PNG [70].
- Manual of Standard Managements in Obstetrics and Gynecology for Doctors, HEOs and Nurses in PNG, Fourth Edition [71].

1.5 Prescribing of medicines in developing countries

Ratanawijitrasin et al. [72] examined the influence of drug policies and essential drug programs on rational drug usage. A major issue was the scarcity of high quality studies that lacked potential bias in assessing the impact of these policies. Many of the inputs such as essential medicines lists, national drug policies, drug lists, STGs, price control, training and quality control were assessed against prescribing indicators such as number of drugs per patient, percentage of patients given drugs, percentage prescribed from the essential drug list, percentage generics prescribed, percentage injections prescribed and percentage of antimicrobials prescribed. They concluded that due to lack of reliable data the question of whether national drug policies and essential drug programs improve drug use was not answerable at present to evaluate the impact of these policies on rational drug use.

The WHO [35] has compiled data on prescribing trends over the period 1990-2006. For example, the prescribing indicators are; average number of medicines prescribed per patient encounter, percentage of medicines prescribed by generic name, percentage of encounters with an antibiotic prescribed, percentage of encounters with an injection prescribed, and percentage of medicines prescribed from an EML or formulary. Other indicators include; patient care indicators, facility indicators, disease-specific medicines use indicators, ARI treatment indicators, diarrhoea treatment indicators and malaria treatment indicators. The WHO/INRUD indicators can be used to explore patterns of prescribing and management of essential medicines in primary care in developing and transitional countries.

The main findings for those indicators over the period 1990-2006 are as follows [35]:

(a). The WHO/INRUD prescribing indicators by time period showed that; prescribing patterns overall have not improved consistently overtime, the percentage of prescribed medicines present on an EML/formulary has increased in 25 years from 65%-90%. This trend has been progressive, and may reflect an increased availability of EML/formularies and/or better awareness of their existence. This has been the most successful indicator for RDU. The percentage of medicines prescribed by generic name increased steadily to reach over 70% in the 2004-2006 period of data collection. This trend may be related to an increased availability of generics and implementation of generic prescribing and dispensing policies, in contrast to these positive trends, the percentage of patients treated according to clinical guidelines remained at substandard levels, below 50% at every period of data collection from 1992 on, the percentage of patients with an antibiotic prescribed remained stable over time at between 40% and 50%, the percentage of patients with an injection prescribed and the average number of medicines per patient showed no apparent trends over the years [35].

(b). The rates of adherence to clinical guidelines over time, by World Bank region showed that; less than half of the patients were prescribed medicines according to clinical guidelines (40%) during the most recent period of data collection, regardless of the geographic origin of studies. The percentage has increased

slightly in studies from Middle East & Central Asia and East Asia & Pacific, suggesting some degree of improvement in adherence to prescribing guidelines between 1982-1994 and 2001-2006 (30%-40%) periods in these regions. However, overall compliance with guidelines remained low [35].

(c). The WHO/INRUD prescribing indicators by prescriber type showed; prescribing patterns were substandard regardless of the type of prescriber. Paramedical health-care workers/nurses prescribed more generic medicines and more medicines from EML/formularies than medical doctors. Results did not uncover other important differences between the prescribing of medical doctors and that of paramedical health-care workers/nurses [35].

(d). The WHO/INRUD patient care indicators by time period showed; there were some improvement over time in many aspects of patient care related to the use of medicines and the percentage of prescribed medicines that are actually dispensed increased by 10% over time to reach 92% in the most recent data collection period. The data from East Asia and Pacific reported the highest percentage of prescribed medicines actually dispensed, the highest percentage of patients given dosage instructions, and the highest percentage of patients with knowledge of the correct dose compared to other regions [35].

(e). The WHO/INRUD health facility indicators by time period showed; the availability of an EML or formulary to prescribers was highly variable across the time periods, ranging from about 40% to about 80% without a consistent pattern. The availability of clinical guidelines to prescribers did not seem to improve over time. In 2004-2006, only half of health-care facilities were reported to have clinical guidelines available during indicator surveys. The percentage of key medicines available in health-care facilities fluctuated between 70% and 80%. Overall, about two out of ten key medicines were not available in the health-care facilities investigated [35].

(f). The data on prescribing of recommended antimalarial treatment over time including all studies of antimalarial use showed; the patterns of antimalarial prescribing worsened during the overall period of data collection. One possible

explanation for this negative trend may be changes in national malaria treatment policy that have occurred in the last 10 years aimed at fighting antimalarial resistance and the lag time inherent in implementing these changes. The percentage of reported malaria cases treated with recommended antimalarial drugs in studies of antimalarial use was only 51% during the period 2004-2006 [35].

(g). The data on prescribing of recommended antimalarial treatment over time comparing studies of children <5 years versus studies of the general population showed; between 1995 and 2006, the percentage of malaria cases treated with recommended antimalarial drugs in children less than 5 years old increased by about 10%, to just under 60% of cases. Overall, the adequacy of antimalarial prescribing, as reported in studies of antimalarial use, has worsened since the 1982-1994 time period both in the general population (adults and children) and in children under 5 years old [35].

(h). The data on inappropriate prescribing of antibiotics over time showed; there was a large, persistent and growing problem of inappropriate use of antibiotics. The percentage of patients prescribed antibiotics inappropriately increased to over 50% in studies conducted between 2001 and 2006, up from 40% in earlier studies. The percentage of antibiotics prescribed in under-dosage remained over 50% in all time periods [35].

(i). The data on inappropriate prescribing of antibiotics by World Bank region showed; that inappropriate prescribing of antibiotics is a widespread problem in every geographic region. In all regions except Latin America, over 40% of reported prescriptions of antibiotics were inappropriate, with countries in South Asia having the highest rates of inappropriate antibiotic use (52%). In Latin America, prescribing insufficient doses of antibiotics was reported more frequently than in other regions and 67% of antibiotics prescribed were dosed incorrectly [35].

(j). The data on inappropriate prescribing of antibiotics by World Bank income level showed; over 60% of prescribed antibiotics in this income group were at

inappropriately low doses. The lowest rates of patients prescribed antibiotics inappropriately were seen in upper-middle and high income countries, although over one third of patients there received antibiotics inappropriately [35].

(k). The data on inappropriate prescribing of antibiotics by type of prescriber showed; there was unsatisfactory antibiotic prescribing patterns by all cadres of health worker. Over 40% of antibiotics were prescribed in under-dosage by all types of health providers. The percentage of patients prescribed antibiotics inappropriately was highest when the reported prescriber was a medical doctor (60%) [35].

A recent study by Dong et al. [73] in Western China evaluated these indices in village health clinics and the results demonstrated that in rural Western China, drug prescribing was far from an optimal level of rational use, especially in terms of prescribing injections and antibiotics. Further intervention studies should be conducted to assess how to promote rational drug prescribing.

Hence, it should be noted that there is no data available thus far for PNG's prescribing indicators.

In addition, the public health issues of poor quality (substandard) medicines in developing countries has been discussed by Newton et al. [74] and strongly suggest that those concerned with medicine quality and access, work positively to facilitate access to the provision of good quality essential medicines and medical products especially in the current climate of a wide availability of counterfeit medicines.

1.6 Prescribing of antibiotics in developing countries

Antibiotics are one of the most frequently prescribed drugs worldwide [75] and there are reported concerns about the continuous indiscriminate and excessive use of antimicrobial agents that promote the emergence of antibiotic resistant organisms in developing countries [76]. Since the antibiotic introduction and their massive use, a significant increase in the prevalence of bacterial resistance has been verified on an international scale [77]. Appropriate antibiotic prescribing is the first step for optimum

antibiotic use and has the potential impact of reducing resistant micro-organisms generated by excessive use [78]. Inappropriate prescribing of antibiotics has been identified in many health facilities in developing countries [39, 79].

High levels of antibiotic prescribing were also found in relation to specific health problems. In Bangkok, Thailand, 63% of patients with URTI were prescribed an antibiotic. Although patients were more likely to be prescribed antibiotics for bacterial conditions, 60% of those with likely viral conditions were prescribed antibiotics [80, 81]. In Indonesia, 90% of the 273 cases of fever of unknown origin were prescribed antibiotics, despite antibiotics not being recommended for this diagnosis [82].

1.6.1 Levels of antibiotics resistance

Many factors are increasing antibiotic resistance and authorities, healthcare providers and patients all have a role in fighting it. Antibiotic resistance is when an antibiotic drug has lost its ability to effectively control or kill bacteria growth. The bacteria targeted adapt by natural selection to become resistant and continue to multiply despite the presence of the antibiotic drug [83].

Outlined below are some studies which describe patterns of resistance. A Japanese study by Okumura et al. [84] reported the results of testing of samples of shigella sonnei from quarantine stations. Ninety percent were resistant to at least one antimicrobial, and 80% were resistant to more than two. In 1999, 47% of the Indonesian strains tested were resistant to more than four antimicrobials [85]. Chien [86] described a resistance surveillance programme in Vietnam. High levels of resistance to co-trimoxazole and ampicillin were found in bacteria causing UTIs and ARIs, and high resistance among Pseudomonas aeruginosa and Staphylococcus aureus.

Very few studies have been undertaken in PNG on antibiotic resistance in relation to drug prescribing, however some related studies are outlined below.

Duke et al. [87] found that when chloramphenicol was used as first line treatment for meningitis followed by ceftriaxone when in vitro resistance *was* shown, there was invariably a very poor outcome from chloramphenicol use and 71% of children died or

had severe neurological complications. Using ceftriaxone as first line treatment was effective in reducing mortality and neurological sequelae from chloramphenicol resistant *Haemophilus* influenzae type (71% *v* 9%, relative risk 0.13; 95% CI 0.02 to 0.87; p =0.013). Changing to chloramphenicol if there was no evidence of in vitro resistance was less than half the cost of empirical use of ceftriaxone for a full course for all children with meningitis.

Manning et al. [88] found that in PNG children with acute bacterial meningitis, all Haemophilus influenza isolates were resistant to chloramphenicol.

Duke [89] found that infections due to antibiotic-resistant bacteria, especially gram-negative bacteria, were a common cause of child mortality in Papua New Guinea. Antibiotic-resistant bacteria included the enteric gram-negative bacilli, especially Escherichia coli, Klebsiella and Enterobacter, and Haemophilus influenzae type b, a major respiratory tract pathogen and cause of meningitis. Among these bacteria there was high-level resistance to standard antibiotics, including chloramphenicol, amoxicillin and cotrimoxazole. Reasons behind the increase in antibiotic resistant bacterial infections were stated as the widespread unregulated use of antibiotics and the very large burden of bacterial infections. Risk factors for development of resistant enteric gram-negative infections included village births, prolonged hospital stay, kwashiorkor in adopted children and previous treatment with broad-spectrum antibiotics.

Lithgow and Kilalang [90] reported an outbreak of nosocomial infection caused by *Klebsiella pneumoniae* in the Special Care Nursery of Port Moresby General Hospital. In the 13 months between October 2007 and October 2008, this organism was cultured from the blood of 57 neonates, of whom 23 died, 16 of the 20 organisms cultured in the first three months were cephalosporin sensitive, but during the next ten months the proportion of sensitive organisms dropped dramatically to 10 of 37. Of the 31 multidrug-resistant organisms six were resistant to all the routinely available antibiotics.

Morewaya [91] in an unpublished report outlined that most isolates from patients at the Port Moresby General Hospital showed varying susceptibility patterns with many organisms showing multiple antibiotics resistant patterns. Of note were coliforms

showing resistance to aminoglycosides and third generation cephalosporins like ceftriaxone and cefotaxime. Urinary coliform isolates also showed varied susceptibility to nitrofurans. Pseudomonas aeruginosa isolates showed multiple drug resistance to piperacillin, carbenicillin as well as quinolones, but was unable to be tested against carbapenems. A Salmonella typhi isolate still showed susceptibility to chloramphenicol and trimethoprim-co-trimoxazole. Haemophilus influenzae isolates showed variable susceptibility patterns to erythromycin and resistance to chloramphenicol, trimethoprim-co-trimoxazole and varied susceptibility to fluoroquinolone, ciprofloxacin. Streptococcus pneumoniae isolates showed varied susceptibility to penicillin and ceftriaxone with most isolates from sputum showing insensitivity to oxacillin. Staphylococcus aureus and MRSA isolates showed variable susceptibility with some organisms showing resistance to vancomycin. The susceptibility patterns given are from disc diffusion testing but with no minimum inhibitory concentration testing. E- test is yet to be introduced into the country. A standardisation process for culture, susceptibility testing and monitoring needs to be in place for an effective infection control strategy.

1.7 Prescribing of antimalarial drugs in developing countries

Malaria remains an important public health concern in countries where transmission occurs regularly, as well as in areas where transmission has been largely controlled or eliminated. Each year an estimated 300 to 500 million clinical cases of malaria occur, making it one of the most common infectious diseases worldwide [92].

A recent study by Bashrahil et al. [93] at two state own hospital outpatients in Yemen, found that chloroquine was the most commonly prescribed antimalarial (42.9% of prescriptions) of the 42 prescriptions investigated, with quinine the second most prescribed (31.0%), Sulfadoxine-pyrimethamine, halofantrine and artemether were prescribed in 4.8%, 2.4% and 2.4% of prescriptions respectively. The remaining seven prescriptions had combinations of more than one antimalarial: chloroquine plus sulfadoxine-pyrimethamine in five cases and quinine plus sulfadoxine-pyrimethamine in two cases.

In South-East Nigeria, Meremikwu et al. [94] conducted a study in a sample of 13 health facilities situated in rural and urban areas and found chloroquine to be the most commonly prescribed drug (30.2%), followed by sulphadoxine-pyrimethamine (22.7%),

and artemisinin alone (15.8%). Monotherapy was 77% of all prescriptions and combination therapy was 20.8% of all prescriptions and the commonest combination treatment was chloroquine with sulphadoxine-pyrimethamine.

In Lagos, Nigeria, a study by Oshikoya [95] involving children attended to at the paediatric general outpatient clinic at Lagos State University Teaching Hospital found that artemesinin based combination drugs constituted 26.2% of all the antimalarial drugs prescribed followed by sulphadoxine-pyrimethamine (20.0%).

In Ghana, Abuaku et al. [96] conducted a study in the Wassa West and the Kassena Nankana districts, found that chloroquine was the most commonly prescribed antimalarial and the proportion of prescriptions containing chloroquine was significantly higher from 84.2%-97% while other antimalarial drugs prescribed were amodiaquine (5%-15%), sulphadoxine-pyrimethamine (1.3%-4%), artemisinin (1%-5.8%) and quinine (1.8%).

The studies mentioned above are similar to PNG in-terms of drug treatments of malaria. Hence, malaria in Papua New Guinea (PNG) is the leading cause of outpatient attendances nationally, the third commonest cause of hospital admission and the second commonest cause of death, and causes the greatest burden of lost disability-adjusted life-years at 4894/100,000 per year [97]. The incidence of malaria is increasing in PNG [98].

1.7.1 Level of antimalarial drug resistance

Reported by Bloland [92], antimalarial drug resistance has emerged as one of the greatest challenges facing malaria control today. Drug resistance has been implicated in the spread of malaria to new areas and re-emergence of malaria in areas where the disease had been eradicated. Drug resistance has also played a significant role in the occurrence and severity of epidemics in some parts of the world.

According to Bloland [92], antimalarial drug resistance has been defined as the “ability of a parasite strain to survive and/or multiply despite the administration and absorption of

a drug given in doses equal to or higher than those usually recommended but within tolerance of the subject".

A number of studies on the susceptibility of *P. falciparum* to chloroquine and other currently used antimalarial drugs have been carried out in Papua New Guinea, where the standard first-line treatment for falciparum malaria and clinically diagnosed malaria is chloroquine for those aged five years and above and amodiaquine for children under 5 years [99]. These studies have shown 51% R1 (resistance level 1), 22% R2 (resistance level 2) and 14% R3 (resistance level 3) level resistance to chloroquine in East New Britain Province. In Madang Province there was 42-46% R1, 3-4% R2 and 2-4% R3 resistance to chloroquine. In Western Province chloroquine resistance was 33% R1, 10% R2 and 3% R3. The level of resistance to amodiaquine was 22-24% and to quinine was 7% in the Madang and East Sepik provinces.

The study by Nsanzabana et al. [100] at a rural health centre in PNG showed that with the high levels of resistance to chloroquine (CQ), amodiaquine (AQ), and sulphadoxine-pyrimethamine (SP), the deployment of the combination of both drugs (CQ plus SP or AQ plus SP) appears to increase clinical effectiveness but does not decelerate growth of resistance.

1.8 Essential medicines list

The concept of an essential medicines list has been accepted since the first WHO Model List of essential drugs was produced in 1977 [101, 102]. It is now known that the use of an essential medicines list is finely interwoven with standard treatment guidelines and from there with maintaining a reliable supply of medicines for quality use. This philosophy or framework is particularly important in settings where resources are limited [103].

For example, the study by Logez et al. [104] found that the WHO model lists of essential medicines could address more clearly the need to use injections safely and appropriately.

Saleh and Ibrahim [105] evaluated the pharmaceutical situation in the context of essential medicines list implementation in Malaysia and found that the majority of the population had access to affordable essential medicines with the average availability of essential medicines was more than 80-95%.

Fattouh and Hamad [106] found that the percentage of drugs prescribed from the essential drug list was 97.9% which clearly indicated that the compliance of physicians with the EDL was generally good in Gaza Strip.

However, on the other hand, experience has shown that even when supply of essential medicines is based on an approved formulary, guidelines or essential medicines list, ample opportunity exists for ineffective, unsafe, or wasteful prescribing [1].

For example, the study by Mohanty et al. [107] on prescription pattern in the Department of Medicine of a Tertiary Care Hospital outpatient department in South India found that there were only 12.0% and 6.4% of fixed drug combinations that were prescribed complied with the WHO essential drug lists in India respectively. This was a very small percentage in terms of compliance with essential medicine list and shows that despite the establishment of the EML, it was still not adhered to.

1.8.1 Advantages of an essential medicines list

The advantages of adopting an essential drugs' list is four-fold. They are: medical, social, economic and administrative [8, 101, 108]. The medical advantages are: it is medically, therapeutically and scientifically sound, and it ensures rational use of drugs; it limits the availability of irrational and hazardous drugs and decreases the risks of iatrogenesis; it improves the possibility of monitoring adverse drug reactions in patients. The economic advantages are: it is economically beneficial to the nation because it prevents wastage of scarce resources on non-essentials; the economies of scale are achieved in the larger production of priority drugs which brings down their prices; and it curtails the aggressive marketing of non-essential formulations. The social advantages are: it responds to the real health needs of the people; it facilitates the dissemination of correct information about the drugs to health personnel, medical practitioners and consumers in general and it makes it imperative to draw up priorities to meet the most

urgent needs of the people for essential health care. The administrative advantages are: it is organisationally sound because it makes quality control easier because of the limited number of drugs to be monitored; it facilitates the streamlining of production, storage and distribution of drugs, because of the smaller number of drugs involved; it helps in the visual identification of the drugs and it facilitates the fixing of prices as well as the revision/withdrawal of duties.

A descriptive cross-sectional study by Fattouh and Hamad [106] evaluated the compliance of physicians with the Palestinian essential drug list (EDL) in all the government primary care clinics in the Gaza Strip. While 67.4% reported currently using the EDL, 51.2% of these physicians reported problems in using it. The percentage of drugs prescribed from the EDL was 97.9% but the percentage of drugs prescribed by generic name was only 5.5%. A copy of the EDL was available in 28.3% of clinics and the availability of key drugs was 82.6%. The compliance of physicians with the EDL was generally good, but more effort is needed to encourage prescribing by generic name and to ensure the supply of key drugs.

1.8.2 Medical and Dental Catalogue (MDC)

The MDC [66] is the essential medicine list for PNG [109] and contained all the essential drugs mostly generics and vaccines used in PNG. It also contained hospital sundries items, laboratory reagents and equipment, X-ray equipment, and surgical instruments and hospital equipment. Items have been divided into five categories according to the qualifications of the health workers allowed to order them [66]. No one can order a drug marked for Medical Officers only without a medical qualification, without approval. The categories are as follows: A = All health workers, B = Medical Officers only, C = Specialist Medical Officer only, D = Pharmacists and Pharmacy Technicians only, and ATO = Anesthetist Technical Officer only.

If a patient under treatment by a Medical Officer or Specialist is to continue under the care of another health worker e.g. an Health Extension Officer, it is the responsibility of the Medical Officer to ensure that sufficient supplies of category B or C item(s) are made available to that particular patient [66].

PNG since 1950 has succeeded in developing, maintaining and financing a pharmaceutical supply system, which provides continuous access to a limited range of essential drugs, of acceptable quality and at reasonable cost, tailored to each level of health care [1, 63]. The MDC [66] has worked well for PNG over the years that other countries in the pacific region have envied. However, as has been observed within the last few years, PNG currently is faced with a problem of drug shortages which is experienced nation-wide [2].

1.9 Standard treatment guidelines (STGs)

Standard treatment guidelines (STGs) describe the preferred pharmaceutical and non-pharmaceutical treatments for common health problems experienced by people in a specific health system. As such, they represent one approach to promoting therapeutic effective and economically efficient prescribing [1].

According to recent documents [1], STGs offer a number of potential advantages: For patients; they provide- consistency among prescribers, leading to reduced confusion and increased compliance, effective and ideally cost-effective treatments are prescribed, and improved supply of drugs is achieved if drugs are prescribed only when needed. For Providers; they provide- expert consensus given on most effective, economical treatment for a specific setting, the provider can concentrate on correct diagnosis, a standard to assess quality of care, and a basis is provided for monitoring and supervision. For Supply Management Staff; it provide a-performance standard for drug supply, so that sufficient quantities of drugs are available for the most commonly treated problems at the different levels of the health system, pre-packaging is facilitated for course-of-therapy quantities of commonly prescribed items for common conditions, and drug demand is more predictable, so forecasting is more reliable. For Health Policy Makers; it enables control of costs by using drug funds more efficiently, a basis is available to assess and compare quality of care, development and implementation of a single set of standard treatments can be a vehicle for integrating special programs at the primary health care facilities, for example, diarrhoea disease control, acute respiratory infection, tuberculosis control, and malaria. Standard treatments do not take the thinking out of health care. Instead, they focus the thinking on other critical aspects of the therapeutic process: careful identification of signs and symptoms; correct

diagnosis; and effective patient counselling on proper use of those drugs or nondrug treatments that will truly benefit the patient [1, 110].

STGs are systematically developed to support healthcare professionals, and sometimes patients, in making decisions about appropriate healthcare in specific circumstances [111].

In an attempt to ensure cost-effective prophylactic use of antibiotics in Caesarean delivery, local clinical guidelines were introduced. They resulted in changes in prescribing patterns of antibiotics. There was a significant decrease in use of 'third' generation of cephalosporin's whereas the use of ''older'' antibiotics with proven efficacy and safety increased [112].

Cabana et al [113] outlined a range of factors as barriers that could affect prescribers' adherence to STGs. These are: On lack of awareness, although many guidelines have achieved wide awareness (ie, immunization guidelines, recommendations for infant sleeping position), for 78% of the guidelines, more than 10% of physicians are not aware of their existence. On lack of familiarity, casual awareness does not guarantee familiarity of guideline recommendations and the ability to apply them correctly. Of the 74 surveys that measured guideline awareness or familiarity, only 4% measured both. In all cases, lack of familiarity was more common than lack of awareness.

On lack of agreement, physicians may not agree with a specific guideline or the concept of guidelines in general. Although they commonly indicate a lack of agreement when asked about guidelines in theory, however, when asked about specific guidelines, physician lack of agreement is less common. The results of studies that examine physician attitudes to guidelines in general should be interpreted with caution when applied to specific guidelines. On lack of self-efficacy, self-efficacy is the belief that one can actually perform a behaviour. It influences whether a behaviour will be initiated and sustained despite poor outcomes. For example, higher self-efficacy in prescribing cholesterol-lowering medications was associated with physicians initiating therapy consistent with national guidelines. Low self-efficacy due to a lack of confidence in ability or a lack of preparation may lead to poor adherence. Sixty-eight per cent of the surveys that reported this barrier involved preventive health education and counselling,

which suggests that poor self-efficacy may be a common barrier to adherence for such guidelines.

On lack of outcome expectancy, it is the expectation that a given behaviour will lead to a particular consequence. If a physician believe that a recommendation will not lead to an improved outcome, s/he will be less likely to adhere. On inertia of previous practice, physicians may not be able to overcome the inertia of previous practice, or they may not have the motivation to change. Although this barrier has not been investigated as widely as others, for all 14 surveys that examined this barrier, more than 20% of respondents indicated that it was a barrier to adherence.

On the external barriers, appropriate knowledge and attitudes are necessary but not sufficient for adherence. A physician may still encounter barriers that limit his/ her ability to perform this commended behaviour due to patient, guideline, or environmental factors. External barriers that limit the ability to perform a recommended behaviour are distinct from lack of self-efficacy. For example, well-trained physicians confident about their counselling skills can still be affected by external barriers (time limitations, lack of a reminder system) that prevent them from adhering to a counselling guideline. However, the persistence of these barriers may also eventually affect physicians' self-efficacy, outcome expectancy, or motivation.

On guideline-related barriers, physicians were more likely to describe guidelines as not easy to use or not convenient when asked about guidelines in theory. When they were asked about barriers for specific guidelines, a significant percentage (more than 10% of respondents) described them as inconvenient or difficult to use in only 6 (38%) of 16 cases. Other guideline characteristics may also affect adherence. Guidelines recommending elimination of an established behaviour may be more difficult to follow than guidelines that recommend adding a new behaviour.

On patient-related barriers, the inability to reconcile patient preferences with guideline recommendations is a barrier to adherence. Patients may be resistant or perceive no need for guideline recommendations. In addition, a patient may perceive the recommendation as offensive or embarrassing. In all the surveys that included patient related factors, more than 10% of physicians indicated them as a barrier to adherence.

On the environmental-related barriers, adherence to practice guidelines "may require changes not under physician control, such as acquisition of new resources or facilities." For example, unavailability of an anaesthetist 24 hours a day may interfere with physician ability to adhere to guidelines aimed at decreasing the rate of elective caesarean deliveries. Many factors described as barriers by more than 10% of respondents, such as lack of a reminder system, lack of counselling materials, insufficient staff or consultant support, poor reimbursement, increased practice costs, and increased liability, may also be factors beyond physician control. With adequate resources or referral privileges, physicians may be able to compensate for other external barriers. Although lack of time is commonly described as a barrier to adherence by more than 10% of respondents, time limitations were not a barrier for mammography referral or breast examination guidelines, management of fever, and hyperbilirubinemia [113]. These barriers identify a plethora of reasons for guidelines not being followed and the challenge of implementing and maintaining the appropriate use of treatment guidelines.

According to MSH [1], local manuals are needed in every health system because of differing decisions about drug choices and the patterns of illness within a country. Disease orientated manuals are called standard treatment guidelines, treatment protocols, or prescribing policies. The selection of drugs to be included on the essential drug list is based on the prevalence patterns of illnesses and the standard treatment guidelines decided upon to treat these conditions. STGs list the preferred drug and non-drug treatments for common health problems experienced by people in a specific health system. Each drug treatment should include each health problem the name, dosage form, strength, average dose (pediatric & adult), number of doses per day, and number of days of treatment. Other information on diagnosis and advice to the patient may also be included [1].

Standard treatments have been used for many years in some countries and now exist for common illnesses of children, adult and obstetrics and gynecology in PNG.

1.9 Study aims and objectives

The aim of this study was to evaluate the system of the management of essential medicines in selected public sector healthcare facilities in PNG with respect to current National Health Department standard treatment guidelines and essential medicines list.

The main objectives of the study are:

- To evaluate the level of appropriateness of drug prescribing by prescribers in selected public sector healthcare locations in PNG.
- To evaluate the level of appropriate and inappropriate drug prescribing among the antibiotics and antimalarial drug groups.
- To identify the mismatch and deficiencies of drugs listed in the STGs and MDC.
- To make recommendations on improving prescribing of essential medicines in PNG.

1.10 Research significance

One of the objectives of the PNG National Drug Policy is to promote the rational drug prescribing. This study evaluated the level of drug prescribing undertaken by health cadres in selected healthcare locations within the PNG public health care system. This is important to ensure that medicines are prescribed appropriately for the benefit of all Papua New Guineans.

This study is of significance to PNG as it will develop a framework that conceptualizes the system of management of essential medicines. Furthermore, it would contribute to the pharmaceutical body of knowledge by providing a sound basis for further research conducted within the drug management system.

2.0 METHODOLOGY

A prospective study was carried out at Losuia Health Centre (LHC), Alotau Provincial Hospital (APH) and Port Moresby General Hospital (PMGH) in PNG. This involved the recording of drug prescribing orders from written prescriptions, the diagnosis made by the prescriber obtained from the health book and where necessary by patient interviews. The health workers at the selected locations were informed of the study being carried out but not of its specific objectives. Those patients who gave consent to participate in the study were interviewed.

2.1 Background to study location

There are a total of twenty provinces in PNG which includes Milne Bay and the National Capital District (NCD). Health care in Papua New Guinea (PNG) is provided through a unified system of community aid posts, rural health centres and provincial hospitals [114]. A network of over 2400 aid posts, 500 health centres and 45 urban clinics are supported by 18 provincial hospitals and one national referral hospital [115]. Those who provide health care include community health workers, nursing officers, health extension officers, dental officers and medical doctors [116].

A health centre and its staff serve a population of between 2000 and 20,000 [117]. Each health centre provides curative and preventive health services and acts as a referral centre for between three and five aid posts [117]. District health centres and hospitals coordinate health services within the district and province and act as a referral point for acute conditions for their district/subdistrict level health centres [117]. The provincial health office coordinates health services within the province, while the National Department of Health provides an advisory role to the provinces [117]. Staff within the National Department of Health have overall responsibility for maintenance of policy and standards, providing technical advice, and management of medical supplies [117].

Nursing Officers (NOs), Community Health Workers (CHWs) and Health Extension Officers (HEOs) undertake most activities at the health centres including diagnosis, prescribing, drug management and referral. On the other hand, most activities in the hospitals that include diagnosis, prescribing, drug management and referral are

undertaken by Medical Officers (MOs) and a few selected Health Extension Officers and Nursing Officers [28].

2.1.1 Losuia Health Centre

At LHC, the data collection took place from 2 to 14 April 2010. LHC (Figure 2.1) serves a population of 23 000 people [118] and acts as the referral centre for other sub-health centres in the Kiriwina-Goodenough District, which has a total population of 49,966 (2000 census) [119]. LHC is headed by a Health Extension Officer (HEO) and staffed with nurses, community health workers (CHWs) and a dental therapist. Due to different languages spoken at Losuia, a CHW was assigned with the approval of the District Health Officer to assist the researcher in the data collection. A space with a table and two chairs next to the treatment room was provided for interviewing patients. The interviewing was undertaken by the CHW who spoke to the patients using their local dialect and the researcher recorded the outcome which took approximately 10 minutes.

Fig. 2.1 A view of Losuia Health Centre

2.1.2 Alotau Provincial Hospital

At APH (Figure 2.2), data collection took place from 2 to 14 July 2010. APH serves a population of 10,000 [120] and acts as the referral hospital for Milne Bay Province, which has a population of 210,412 [119, 120]. It is headed by a Chief Executive Officer. The

interview of patients was carried out at the hospital pharmacy when patients came to collect their medicines. The interview was undertaken by the researcher with assistance from the pharmacist and pharmacy technician.

Fig. 2.2 A view of Alotau Provincial Hospital Pharmacy customer service counter

2.1.3 Port Moresby General Hospital

At the PMGH (Figure 2.3), data collection took place from 25 September to 6 October 2010. PMGH is headed by a Chief Executive Officer who oversees the running of the hospital. It serves a population of 254,158 (2000 census) [120] and is the only national referral hospital in PNG for the whole population. Patient interviews were carried out at the hospital pharmacy when patients came to collect their medicines. The interview was undertaken by the researcher with assistance from the pharmacists and pharmacy technicians.

Fig. 2.3 A view of Port Moresby General Hospital [121]

2.2 Data recording sheet

A data recording sheet was developed to collect data for each drug prescribed in the above health facilities. The data recording sheet collected the participant's prescription details and included patient's date of birth/age, weight, gender and date attending clinic, name of healthcare location, current diagnosis, current medicines prescribed (name, dose, frequency, duration, total number supplied), prescriber category, any injections given including total number supplied, additional current chronic medication still being taken by the patient, list of drug items out-of-stock on the day prescribed, and how out-of-stock items prescribed on the day were managed in the dispensary/pharmacy. Data on current and relevant previous diagnoses and medications prescribed were recorded from a health booklet that was kept by each patient. A participant of 13 years or less was classified as a child.

For reasons of literacy, the data sheet was often completed by the researcher on questioning the patient/carer when they understood Pidgin-English. The Pidgin-English language is the language widely spoken in PNG and was used for oral communication throughout the study, while English was used as appropriate [28].

2.3 Administration of the protocols

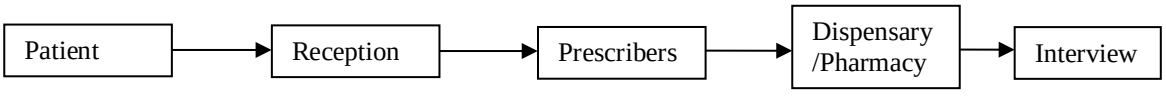

Fig.2.4: The usual patient flow pattern at the health centre or hospital [122].

Normally, the patient would go to the cashier, pay the required outpatient/consultant entry fee of 20 toea (100 toea = Kina) at LHC, 10 Kina at APH and 2 Kina for outpatient and 10 Kina for consultation at PMGH, and proceed to the reception room to wait in a queue. Drugs were issued free to patients at LHC, 2 Kina per prescription at APH and 1 Kina per drug prescribed at PMGH (PNGK1.00≈US $0.44).

At LHC, when their turn came, patients were referred to see either a Nursing Officer (NO) or a Community Health Worker (CHW). The complicated cases would be referred to the HEO. If the case was serious, the patient would be referred to APH for further investigation. This hospital was not easily accessible as it involved 10–12 hours of travel by boat or 30 minutes by air subject to availability of funds. Either service was available approximately once a week. At APH and PMGH, patients were referred to see either a NO, HEO or Medical Officer (MO). The complicated cases would be referred to the Specialist Medical Officer (SMO) or the Senior Specialist Medical Officer (SSMO). The diagnosis and prescribed medicines were written into the patient's health book, which they kept. The patient then proceeded to the pharmacy for the supply of medicines. After receiving their medicines, the patient was then asked to see the researcher.

2.4 Sample selection

The study sites were chosen for convenience. Consecutive outpatients seeking medicines during the 2-week study period at each site were screened and, if eligible, were invited to participate in the study. Only those patients or carers who agreed to participate in the study were informed of the objectives and significance of the study. In addition, they were provided with a copy of patient information sheet (Appendix 1) explaining the purpose of the study and participant consent form (Appendix 2) where they signed indicating their consent to participate in the study counter-signed by the researcher. Subjects were deemed eligible provided they carried with them their health book and consented to participate in the study. However, eligible subjects were excluded if they were too ill to be interviewed, could not communicate or there was insufficient time for the consultation. Where the diagnosis was unclear, the patient was

excluded from the study. In the case of children, their parent or guardian was interviewed.

2.5 Analysis of data

The appropriateness of prescribing was based upon compliance with relevant PNG guidelines [67-71, 123]. The criteria were based on the drug selection, drug dosage, drug frequency and drug duration as specified in the guidelines. Furthermore, 'overall appropriateness' was defined as appropriateness according to the previous four criteria plus the category of the prescription item complying with legislative restrictions on non-medical prescribers as defined in the Medical and Dental Catalogue [66] and drug supplied according to prescription requirements. The diagnosis was that recorded by the prescriber in the patient's health book, which they had with them at the interview. Allocation of prescribing appropriateness was made by the researcher where no doubt existed and this was reviewed by two pharmacist experts in rational drug use in developing countries. Where doubt occurred regarding the allocation, a consensus decision was made by the researcher and the two independent experts. Data from the recording sheets were entered into an Excel spread-sheet. Prescribed drugs were classified according to the ATC codes [124]. Tables were generated using the statistical software program SAS version 9.2 (SAS Institute Inc., Cary, USA, 2008). P-values to compare the profiles of subjects against various independent variables (including pharmacy location, gender and age group) were calculated using the chi-squared statistic unless otherwise specified. In all analyses, a P-value <0.05 was taken to indicate a statistically significant association.

2.5.1 Definition of appropriateness

The criteria for assignment of appropriateness were based on the following as specified in the PNG guidelines:

- Drug selection: Drugs were listed in the guidelines by appropriate Health Department Authorities for specified diseases and are prescribed by the prescriber based on the diagnosis given on consultation. The drug could be taken orally, topically, or by injection. The diagnosis used was that written by the prescriber in the health book.

- Drug dosage: The dosages were those stated in the guidelines. For the different age groups, doses may be specified on a mg/kg basis. The weight was obtained from the patient's health book. All children were weighed on the day of consultation.

- Drug frequency: How many times within a day, a week or a month the drug has to be taken was as specified in the guidelines for the diagnosis.

- Drug duration: How long a drug has to be taken as specified based for the diagnosis in the guidelines.

When a drug was selected or prescribed by a prescriber for a particular diagnosis and meet all the above requirements, it was classified as 'appropriate prescribing'. However, if any of the above was not adhered to, it was classified as 'inappropriate prescribing'.

2.5.2 Additional criteria for appropriateness of prescribing

The "overall appropriateness" was defined as prescribing appropriateness as above, and in addition to:

- Pharmacy supply in accordance with prescription requirements: Drugs prescribed were supplied fully as required by the prescription and in accordance with the guidelines.

- Category of the prescription according to legislative restrictions on non-medical prescribers: Drugs were listed in the PNG essential drug list [66] and classified according to the qualifications of the health workers prescribing them. The drug categories range from A-E. A=All health workers. B=Medical Officers. C=Specialist Medical Officers. D=Restricted to special indications only.

When all of the above criteria were met, the prescription item was classified as “Overall Appropriateness” of drug prescribing. Any variation in one of the above was classified as “overall inappropriateness of drug prescribing.

Allocation of appropriateness was made by the researcher where no doubt existed and this was reviewed by two experts who are pharmacist experts in rational drug use in developing countries. Where doubt regarding the allocation occurred, a consensus decision was made by the researcher and the two independent experts.

2.6 Statistical analysis

Data from the recording sheets were entered into an Excel® spread sheet with the following headings inserted in the columns; Location code, Prescriber, AMH classifications, Date of birth, Age, Year of birth, Weight, Gender, Treatment guidelines compliance, Drug prescribed name, Drug dosage form, Drug category, ATC codes, Drug strength, Drug dose, Drug frequency, Drug period, Drug duration, quantity dispensed, Drug availability, Selection, Dosage, Frequency, Duration, Supply, Drug out of stock, Guidelines, Prescription, Appropriateness.

Prescribed drugs were classified according to the Anatomic, Therapeutic, Chemical Classification (ATC) codes [124]. Diagnoses were classified according to the PNG STGs.

Tables were generated using the statistical software program SAS version 9.2 (SAS Institute Inc, Cary, USA, 2008). P-values to compare the profile of subjects against various independent variables (including pharmacy location, gender and age group) were calculated using the Chi-square statistic unless otherwise specified and include the following at all locations;

- Demographic description of all patients studied (gender & age group)
- The percentages of the most common diseases diagnosed
- The percentages of the most common medicines prescribed
- Prescriber classification for the treatment of patients
- Percentages of appropriate and inappropriate prescribing based solely on drug selection, dosage, frequency and duration for each prescription item
- Percentages of inappropriate prescribing by each prescriber

- Overall percentages of appropriate / inappropriate prescribing for children and adults based on drug selection, dosage, frequency, duration and other criteria such as diagnosis according to guidelines, pharmacy supply in accordance with prescription requirements, and category of the prescription according to legislative restrictions on non-medical prescribers.
- Antimalarial and antibiotic use according to gender and age group
- AMH disease classifications for subjects receiving antimalarial and antibiotic drugs
- The percentage of antimalarial and antibiotic drugs prescribed
- Appropriate / Inappropriate prescribing of antimalarial and antibiotic drugs for adults and children based on drug selection, dosage, frequency, and duration
- Overall appropriateness quality of prescribing antimalarial and antibiotic drugs by prescribers

In all analyses, a p-value less than 0.05 was taken to indicate a statistically significant association for the following;

- Demographic description of all patients studied for the age groups
- Prescriber classification for the treatment of patients taken individually and as a group
- Percentages of appropriate and inappropriate prescribing based solely on drug selection, dosage, frequency and duration for each prescription item
- Percentages of inappropriate prescribing by each prescriber
- Overall percentages of appropriate / inappropriate prescribing for children and adults based on drug selection, dosage, frequency, duration and other criteria such as diagnosis according to guidelines, pharmacy supply in accordance with prescription requirements, and category of the prescription according to legislative restrictions on non-medical prescribers.
- Antimalarial use according to gender
- Antibiotic use according to age group
- The percentage of antimalarial and antibiotic drugs prescribed
- Appropriate / Inappropriate prescribing of antimalarial and antibiotic drugs for adults and children based on drug selection, dosage, frequency, and duration

- Overall appropriateness quality of prescribing antimalarial and antibiotic drugs by prescribers

A comparative analysis was undertaken to differentiate the lists of essential medicines available in the PNG essential drug list (MDC) [66] and the standard treatment guidelines. Ten diseases with their treatments as listed in the guidelines were chosen to represent acute and chronic diseases and these were malaria, anaemia, asthma, tuberculosis, arthritis, diabetes, high blood pressure, psychosis, urinary tract infection, and pneumonia, These were analysed for differences in drugs included in the STGs and in the MDC. Where discrepancies were identified, the eTG (Australia) was used to provide information for drugs in the MDC but not in the guidelines.

2.7 Ethical issues

The research protocol was approved by the Milne Bay Province Medical Research Advisory Committee and the PMGH Executive Committee, including giving ethical clearance for it to be carried out in LHC, APH and PMGH. In addition, it was approved by the Human Research Ethics Committee of Curtin University dated 16 July, 2010 with the protocol approval number PH-10-2010.

3.0 APPROPRIATENESS OF DRUG PRESCRIBING AND SUPPLY OF MEDICINES AT THE THREE LOCATIONS IN PNG

3.1 Results

During the two week study period at each location, 356 subjects were enrolled at LHC, 318 at APH, and 416 at PMGH. It was estimated that of those invited to participate in the study, approximately 90% agreed and completed the interview.

Table 3.1 Demographic description of out-patients at Losuia Health Centre (LHC), Alotau Provincial Hospital (APH) and Port Moresby General Hospital (PMGH)

Variable	**Place**			**Total**	**p-value†**
	LHC	**APH**	**PMGH**	**n (%)**	
	n (%)	**n** (%)	**n** (%)		
Gender					0.1094
Females	192 (53.9)	178 (56.0)	202 (48.6)	572 (52.5)	
Males	164 (46.1)	140 (44.0)	214 (51.4)	518 (47.5)	
Age group*					<0.0001
Adult	216 (60.9)	212 (66.7)	320 (76.9)	748 (68.7)	
Child	139 (39.2)	106 (33.3)	96 (23.1)	341 (31.3)	
Total	356	318	416	1090	

* Note that age group was missing for one record at LHC. † The p-values are across locations

Data for the basic demographic details of participants at LHC, APH and PMGH are shown in Table 3.1. The gender distribution was similar across the three sites which indicate no significant difference in gender in the population, but there was a significant difference between adults and children. Approximately one-third of the subjects were children at the LHC (39.2%) and APH (33.3%) locations but a significantly smaller proportion (less than one quarter or 23.1%) of referrals to the national referral hospital were children. It is notable that the number of children in the samples was less than 40%, which is lower than expected based on the population data. A child in the PNG health system is classified as thirteen or less years old whereas the population data only include those up to 13 years of age and any 13 year old would be excluded from the population data [98].

Table 3.2 Frequency of prescribing of drugs, antibiotics and injections at Losuia Health Centre (LHC), Alotau Provincial Hospital (APH) and Port Moresby General Hospital (PMGH)

Items prescribed per patient	**LHC N (%)**	**APH N (%)**	**PMGH N (%)**	**Total N (%)**
1	85 (23.9)	96 (30.2)	114 (27.4)	295 (27.1)
2	138 (38.8)	119 (37.4)	141 (33.9)	398 (36.5)
3	87 (24.4)	62 (19.5)	98 (23.6)	247 (22.7)
4	32 (9.0)	31 (9.8)	42 (10.1)	105 (9.6)
> 4	14 (3.9)	10 (3.1)	21 (5.1)	45 (4.1)
Total	356	318	416	1090
Mean	2.3	2.2	2.3	2.3 (p=0.1747)
Antibiotics prescribed (patient-based)	219/356 (61.5)	185/318 (58.2)	233/416 (56.0)	637/1090 (58.4)
Antibiotics prescribed (drug-based)	279/828 (33.7)	202/696 (29.0)	278/971 (28.6)	759/2495 (30.4)
Injections prescribed (patient-based)	66/356 (18.5)	18/318 (5.7)	17/416 (4.1)	101/1090 (9.3)

As shown in Table 3.2, more than one-half of the patients were prescribed one or two medications with a range of one to seven. Less than 5% were prescribed more than four medications. There was no difference (P=0.175) in the mean number of drugs prescribed per person at each location. Overall 58.4% of patients (Table 3.2) were prescribed antibiotics at their consultation and a small proportion an injection (9.3%).

Table 3.3 The most common diseases diagnosed at all locations (note that some patients were allocated more than one diagnosis)

Diagnosis/diseases	**Frequency (%)**
Malaria	313 (23.2)
Acute soft tissue injuries	141 (10.4)
Anaemia	120 (8.9)
Respiratory problem – asthma, COPD, etc	118 (8.7)
Cough	79 (5.9)
Others	580 (42.9)

The most common disease diagnosed was malaria accounting for more than one-fifth of the diagnoses (Table 3.3). The high malaria diagnosis reflected the high rate of malaria infection in PNG as being holoendemic for malaria. Soft tissue injuries and anaemia (iron products in pregnancy) were the next most frequent diagnoses. There was a low level of chronic diseases diagnosed.

Malaria includes fever, uncomplicated malaria, severe malaria, and treatment failure malaria. Acute soft tissues injuries includes sores, boils, abscesses, lacerations, injuries, wounds, burns, mastioditis, backaches, fractures, dislocations, tissues infections and pyomyocitis. Asthma and COPD (chronic obstructive pulmonary disease) includes influenza, pneumonia, and upper respiratory tract infections. Cough include simple cough.

According to the PNG National Health Plan 2011-2020 [98], the leading causes of outpatient visits 2007-2008 in PNG were malaria, skin disease, simple cough, pneumonia, diarrhoea, other respiratory diseases, and accidents. Most of these diseases would require prescribed antibiotics for treatment. Therefore, it is concurrence with this study data (Table 3.3).

Table 3.4 The most common medicines prescribed at each location at Losuia Health Centre (LHC), Alotau Provincial Hospital (APH), and Port Moresby General Hospital (PMGH)

Medications	**Place**			**Total**
	LHC n (%)	**APH** n (%)	**PMGH** n (%)	n (%)
Amoxicillin products	104 (12.6)	104 (14.9)	147 (15.1)	355 (14.2)
Paracetamol	99 (12.0)	99 (14.2)	146 (15.0)	344 (13.8)
Artemether/Artesunate	41 (5.0)	78 (11.2)	67 (6.9)	186 (7.5)
Chloroquine	107 (12.9)	52 (7.5)	3 (0.3)	162 (6.5)
Sulphadoxine-pyrimethamine	69 (8.3)	29 (4.2)	28 (2.9)	126 (5.1)
Others	408 (49.3)	334 (48.0)	580 (59.7)	1322 (53.0)
Total	828	696	971	2495

Amoxicillin products were commonly prescribed at each location (Table 3.4), followed by paracetamol and its combinations, Artemether/artesunates and other antimalarials were the next most frequently prescribed. This was in line with the common diseases treated as shown in Table 3.4. The prevalence of malaria (Table 3.3) in almost one-quarter (23.2%) of patient diagnoses was the major disease managed and hence has a major impact on health resources in PNG.

Table 3.5 Prescriber classification for the treatment of patients at Losuia Health Centre (LHC), Alotau Provincial Hospital (APH) and Port Moresby General Hospital (PMGH)

Prescriber*	**Place**			**Total** n (%)	**p-value†**
	LHC n (%)	**APH** n (%)	**PMGH** n (%)		
Type: CHW	112 (31.5)	0 (0.0)	0 (0.0)	112 (10.3)	<0.0001
DO/DT/RDO	3 (0.8)	2 (0.6)	4 (1.0)	9 (0.8)	
HEO/RHEO	45 (12.6)	73 (23.0)	6 (1.4)	124 (11.4)	
NO	196 (55.1)	48 (15.1)	11 (2.6)	255 (23.4)	
MO/RMO/SMO	0 (0.0)	195 (61.3)	395 (95.0)	590 (54.1)	
Group Non-medical	356 (100.0)	123 (38.7)	21 (5.1)	500 (45.9)	<0.0001
Medical	0	195 (61.3)	395 (94.9)	590 (54.1)	

*CHW= Community Health Worker; DO/DT/RDO= Dental Officer, Dental Therapist, Resident Dental Officer; HEO/RHEO= Health Extension Officer (R =Resident); NO= Nurse Officer; MO/RMO/SMO= Medical Officer R= Resident S= Specialist. †The p-values are across locations

Most of the drug prescribing (Table 3.5) at LHC which is a rural health centre was undertaken by CHWs (31.5%) and NOs (55.1%). At APH and PMGH which are urban hospitals, the drug prescribing was mostly undertaken by MOs and SMOs. When prescribers were grouped as non-medical and medical at each location, there was a significant difference between prescriber categories dependent on location. It is notable that there were very few patients for which prescribing was performed by Dental Officers, Dental Therapists or Resident Dental Officers (DO/DT/RDO).

Table 3.6 Numbers and percentages of appropriate and inappropriate prescribing by location based solely on drug selection, dosage, frequency and duration for each prescription item.

Criterion	**Place**			**Total**	**p-value†**
	LHC n (%)	**APH** n (%)	**PMGH** n (%)	n (%)	
Drug Selection					<0.0001
Appropriate	753 (90.9)	480 (69.0)	702 (72.3)	1935 (77.6)	
Inappropriate	75 (9.1)	216 (31.0)	269 (27.7)	560 (22.4)	
Drug Dosage					<0.0001
Appropriate	673 (81.6)	650 (93.4)	957 (98.6)	2280 (91.5)	
Inappropriate	152 (18.4)	46 (6.6)	14 (1.4)	212 (8.5)	
Drug Frequency					0.0001
Appropriate	790 (95.8)	685 (98.6)	956 (98.5)	2431 (97.6)	
Inappropriate	35 (4.2)	10 (1.4)	15 (1.5)	60 (2.4)	
Drug Duration					<0.0001
Appropriate	731 (88.6)	684 (98.4)	958 (98.7)	2373 (95.3)	
Inappropriate	94 (11.4)	11 (1.6)	13 (1.3)	118 (4.7)	
Summary*					<0.0051
Appropriate	557 (67.3)	432 (62.1)	676 (69.6)	1665 (66.7)	
Inappropriate	271 (32.7)	264 (37.9)	295 (30.4)	830 (33.3)	

*Relates to the occurrence of at least one of the four prescribing criteria deemed inappropriate for a prescribed drug for it to be classified as Inappropriate. †The p-values are across locations.

The frequency of inappropriate prescribing based upon an application of the PNG guidelines at each location is shown in Table 3.6. At APH and PMGH, inappropriate drug selection was at levels of 31.0% and 27.7% respectively. It is notable that medical doctors performed most of the drug prescribing in these centres. The prevalence of inappropriate drug prescribing across all locations based on the guideline parameters of drug selection, drug dosage, drug frequency and drug duration combinations was 33.3%, ranging from 30.4% to 37.9% for the different centres. One or more of the previous criteria being inappropriate rendered the item inappropriate in the “summary row”. There were significant differences for each inappropriate category and the summary category assessed across the locations studied.

Table 3.7 Overall percentages of inappropriate prescribing for children and adults based on drug issues (selection, dosage, frequency and duration), and prescriber appropriateness. The proportions of inappropriateness on grounds of any drug issue, and any issue (drug or prescriber) are also shown. The p-values are for the comparison of inappropriateness between Losuia Health Centre (LHC), Alotau Provincial Hospital (APH) and Port Moresby General Hospital (PMGH).

Criterion	Place			Total	p-value*
	LHC	APH	PMGH		
Drug Selection					
Adult	10.0	23.6	31.0	22.8	<0.0001
Child	7.2	48.1	15.7	21.6	<0.0001
Drug Dosage					
Adult	9.3	5.6	0.9	4.7	<0.0001
Child	33.8	9.0	3.3	17.7	<0.0001
Drug Frequency					
Adult	4.2	2.1	1.8	2.6	0.0206
Child	4.3	0	0.5	1.9	0.0005
Drug Duration					
Adult	11.2	1.5	0.8	4.0	<0.0001
Child	11.5	1.9	3.3	6.3	<0.0001
Any drug issue					
Adult	27.0	31.6	33.5	31.1	0.0452
Child	42.3	52.4	19.0	38.5	<0.0001
All ages	32.7	37.9	30.4	33.3	0.0051
Prescriber issue					
Adult	3.3	6.6	14.6	9.0	<0.0001
Child	0.7	4.8	2.0	2.2	0.0072
All ages	2.3	6.1	11.9	7.0	<0.0001
All criteria above					
Adult	29.1	32.4	36.9	33.4	0.0126
Child	42.6	53.8	21.9	39.9	<0.0001
All ages	34.2	38.9	33.7	35.3	0.0606

*The p-values are across locations

Table 3.7 shows prescribing data separated for adults and children. Children received a higher number of inappropriate doses than adults and these were significantly different across the locations (p<0.0001). The “overall inappropriate” drug prescribing included the additional criterion of inappropriate item prescribed based upon legislative restrictions on non-medical prescribers. This gives the “overall” inappropriate levels of 33.4% for adults and 39.9% for children. It was 53.8% for children at APH.

Table 3.8 Numbers and percentages of inappropriate prescribing by each prescriber classification (summarized across all sites). The p-values compare the significance of inappropriate prescribing between different prescriber classifications.

Prescriber	**N**	**Criterion**				**Overall**
		Selection n (%)	**Dosage** n (%)	**Frequency** n (%)	**Duration** n (%)	n (%)
CHW	251	20 (8.0)	49 (19.5)	10 (4.0)	28 (11.2)	82 (32.7)
DO/DT/RDO	18	0	0	0	0	0
HEO/RHEO	289	73 (25.3)	35 (12.2)	10 (3.5)	21 (7.3)	119 (41.2)
MO/RMO/SMO	1344	421 (31.3)	33 (2.5)	21 (1.6)	20 (1.5)	467 (34.8)
NO	593	46 (7.8)	95 (16.1)	19 (3.2)	49 (8.3)	162 (27.3)
p-value†		<0.0001	<0.0001	0.0373	<0.0001	<0.0001

*CHW= Community Health Worker; DO/DT/RDO= Dental Officer, Dental Therapist, Resident Dental Officer; HEO/RHEO= Health Extension Officer (R =Resident); NO= Nurse Officer; MO/RMO/SMO= Medical Officer R= Resident S= Specialist. †The p-values are across prescriber categories.

As shown in Table 3.8, there were statistically significant differences observed on the level of inappropriate prescribing by prescriber category on drug selection (p < 0.0001), drug dosage (p< 0.0001), drug frequency (p=0.0373) and drug duration (p< 0.0001). There was a significant difference (p=0.00014) in the “inappropriateness” of drug prescribing with respect to prescriber category. HEOs showed the highest levels of inappropriate drug prescribing (41.2%) with CHWs and MOs showing moderate levels (Table 3.8)

Table 3.9 Frequency of prescribed drugs supplied from the dispensary in the three locations (FS=full supply, NS=no supply, OS=over supply, US=under supply)

Location	Freq	Total (%)
LHC	FS	637 (77.8)
	NS	40 (4.9)
	OS	51 (6.2)
	US	91 (11.1)
	Total	**828**
APH	FS	616 (88.5)
	NS	66 (9.5)
	OS	9 (1.3)
	US	5 (0.7)
	Total	**696**
PMGH	FS	897 (92.4)
	NS	72 (7.4)
	OS	0 (0.0)
	US	2 (0.2)
	Total	**971**
Centres combined Total	FS	2150 (86.5)
	NS	178 (7.2)
	OS	60 (2.4)
	US	98 (3.9)
	Total	**2486**

Table 3.9 shows that some items were not supplied by the dispensary/pharmacy because of stock shortages. At LHC, the NS was 4.9%, 9.5% at APH and 7.4% at PMGH. In some cases an over- or under-supply also occurred. On the overall, 86.5% of all drugs prescribed during the study period were provided and 13.5% had problem with either no supply, over-or under-supply.

3.2 Discussion

This is the first study that has systematically evaluated the prevalence of inappropriate drug prescribing by medical and non-medical staff in different healthcare locations in PNG. A sample in excess of 1000 patients was evaluated over three locations ranging from a rural health centre, a provincial hospital and the main referral hospital in the country and a broad range of trained staff to manage their dispersed population. A hierarchical health system applies in the country including a referral system; however in remote villages it may be difficult for patients to be transported to a larger referral clinic.

The prevalence of malaria in almost one-quarter of patient diagnoses was the major disease managed and hence has a major impact on health resources in PNG. The number of antibiotics prescribed per patient encounter was high especially at LHC (Table 3.2).

3.2.1 Poly-pharmacy

The number of drugs prescribed per patient was within an acceptable range. Whilst the WHO guidelines on drug use prescribing had reference values of 1.6-1.8 drugs per encounter [125], the average of 2.3 drugs prescribed per patient encounter as seen in this study is acceptable. This average is similar to other reports from developing countries with programmes promoting rational drug use as well as standards proposed for the locality in Bangladesh and Lebanon [125], Bahrain [126], Mali [127], and United Arab Emirates [128, 129].

3.2.2 Injections

The number of injections prescribed was low accounting for less than 9.3% (Table 3.2) of all items prescribed which was lower or at least compared to the WHO reference values of 10.1-17.0 [125]. Injections may be an issue in some developing countries like Nigeria [130], Sudan and Uganda [131], however prescribing of injections in PNG was low according to the data in this study. Therefore, unnecessary prescribing of injection where an oral formulation was effective rarely occurred in the locations evaluated.

3.2.3 Inappropriate drug prescribing

This study has found high levels of inappropriate drug prescribing in each location evaluated. Inappropriate drug prescribing can be caused by one or more of the following;

- Drug selection:-The drug selected and prescribed is not listed in the standard treatment guidelines for that diagnosis.
- Drug dosage:-The dosage prescribed, or dosage calculated by weight or the product of the dosage and body weight did not conform with the dosage stated in the standard treatment guidelines.
- Drug frequency:-Non-conformable with the drug frequency stated in the standard treatment guidelines. Where three times a day was indicated in the standard treatment guidelines, then eight hourly was also deemed appropriate.
- Drug duration:-Where the period over which dosage administration should occur as specified in the standard treatment guidelines was not prescribed.

The “overall inappropriateness” with regard to drug prescribing was the overall non-compliance according to the guidelines which relates to drug selection, dosage, frequency and duration as mentioned above plus pharmacy supply not in accordance with prescription requirements (Drugs prescribed did not conform to the prescription requirements and in accordance with the guidelines. They were either not supplied, under-supplied, or over-supplied) and category of the prescription not according to legislative restrictions on non-medical prescribers (Drugs were listed in the PNG essential medicine list [66] and classified according to the qualifications of the health worker group prescribing them. The drug categories range from A-E. A=All health workers. B=Medical Officers only. C=Specialist Medical Officers only. D=Restricted to special indications only. E=Pharmacist and Pharmacy Technicians only. For example, if a nurse prescribed a drug listed in the B Category (which only medical officers were allowed to prescribe) then it was deemed inappropriate within this part of the analysis).

It is notable that at the rural health centre, where based upon an application of the guidelines, 32.7% of prescriptions were inappropriate, mainly arising from inappropriate drug dosages. This centre had the highest number of children, requiring more dosage

calculations than at the other centres. At the provincial and referral hospitals, drug selection was the main contributor where medical officers carried out the majority of the prescribing. All prescribing is carried out by non-medical staff at health centres whereas a combination of medical and non-medical staff prescribed at hospitals. It is notable that non-medical prescribers at LHC had lower levels of inappropriate drug selection but higher levels of drug dosage errors. This might indicate they follow guidelines for selection, but dosage calculations maybe a difficulty for them. At APH and PMGH the major error was inappropriate drug selection. This is further emphasised with data shown in Table 3.8 where Community Health Workers and Nurse Officers showed very low levels of selection errors but high levels of calculation errors. The reverse situation occurs with Medical Officers. The small amount of prescribing recorded for the dental categories showed correct prescribing for all medications.

3.2.4 Drug prescribing by prescribers

Prescribing is permitted by a range of medical and non-medical workforce in PNG owing to a lack of availability of medical officers in rural areas. A study in the UK by Carey and Stenner [132] refers non-medical prescribing to nurses, pharmacists, and allied health professionals. In this study, the non-medical prescribers refer to community health workers, nurses, and HEOs while the medical prescribers refer to RMOs, MOs, SMOs and SSMOs. There is a limited formulary permitted for non-medical prescribers compared to medical prescribers defined in the Medical and Dental Catalogue [66] which is the Essential Medicines List for PNG. The study found, 54.1% of prescribing was from medical qualified staff (Table 3.5) with the remainder by a range of non-medical prescribers. Of this latter group, Health Extension Officers have received more comprehensive training in diagnosis and prescribing than Community Health Workers and Nurse Officers, who however carried out most of the non-medical prescribing reported in this study. A study by Joshua and Sunderland [28] found that the majority of prescribing was performed by nurses (94.3%), while HEO (4.0%) and doctor (1.7%) at urban clinics in NCD, PNG. Inappropriate prescribing by HEOs was 41.2% and Medical Officers was 34.8% and community health workers made the highest percentage of dosage errors.

Data in Table 3.5 indicates that most of the drug prescribing was undertaken by CHWs (31.5%) and Nurses (55.1%) at LHC. As shown in Table 3.8, the limited knowledge and skills of CHWs on drug matters may have contributed to the inappropriate prescribing (19.5%) on drug dosages. Studies in Nigeria indicated a prescriber level of training or lack of training is one factor that would influence drug prescribing in health facilities [39]

It is notable that non-medical and medical prescribers gave rise to different types of inappropriate drug prescribing. Community Health Workers for example, seemed to pay close attention to the guidelines with respect to drug selection but had greater difficulty determining an appropriate dosage and duration. Medically qualified prescribers more frequently selected drugs not recommended in the guidelines but usually prescribed the correct dosage and frequency (Table 3.6).

3.2.5 Factors leading to inappropriate drug prescribing

The underlying factors leading to inappropriate drug prescribing are complex. They include societal and health system factors as well as education, training, continuing professional education and access to data [6, 29, 34, 40, 53, 101]. The guidelines used for this study were available to prescribers at each setting. Long queues of patients were a common occurrence in all settings increasing the stress on staff to manage these patients. The three locations evaluated in this study were all publicly funded institutions. Patients paid only a nominal fee which should not be a major barrier to access services. In LHC, isolation and a lack of doctors are major factors and ill patients may have significant transport difficulties to attend a provincial hospital. It was noteworthy that of the 356 patients evaluated in this study at LHC, only 11.5% were diagnosed or prescribed for chronic diseases such as hypertension and types 1 or 2 diabetes.

3.2.6 Interventions to address the inappropriate levels of prescribing

The interventions to address the inappropriate levels of prescribing need to be carefully considered prior to implementation. These would include reviews of the prescribing guidelines and their alignment with the drug (medical and dental) catalogue [66]. Currently methyldopa is stated in the guidelines as the only choice for hypertension, when enalapril is in the essential drugs list and only lifestyle changes for Type II diabetes when metformin is in the essential drugs list. Since non-medical prescribers are the only

ones available at health centres all over PNG and many of these are isolated from other services, this may include a review of the range of drugs that can be prescribed by non-medical prescribers, especially allowing broader access and updated treatment of hypertension and Type 2 diabetes. This could include a separation of the limitations into specific groups of non-medical prescribers.

The prescribing categories may need to be reviewed to ensure that current practice where appropriate was included with the standard treatment guidelines in PNG. For example, cloxacillin and indomethacin capsules were category B items and only medical prescribers were allowed to prescribe them but were available in the health centres where only non-medical prescribers were available.

3.2.7 Inappropriate prescribing for adults compared with children

It is notable that the number of children in the samples was less than 40%, which is lower than expected based on the population data. However a child in PNG is classified as 13 or less years old in the health system. Inappropriate prescribing by medical officers was 34.8% and community health workers 32.7% for adults and children combined (Table 3.8). It is notable (Table 3.7) that overall inappropriate prescribing was higher for children (39.9%) compared with adults (33.4%).

3.2.8 Consequences of inappropriate drug prescribing

The consequences of inappropriate drug prescribing may result in the following;

- Waste of resources on the individual and the society.
- Adverse drug reactions. In the UK about 6.5% of admissions had been attributed to adverse reactions to drugs with a mortality of about 0.15% [32].
- Significant patient harm in terms of poor outcomes.
- Drug resistance (antibiotics & antimalarials).
- High healthcare service utilization.
- High cost on patient and society: The cost to the nation was been estimated at a staggering sum of £466 million annually [133].

A study by Ruggiero et al [134] on the impact of inappropriate drug prescribing among nursing home residents indicated factors such as adverse drug reactions, significant patient harm in terms of poor outcomes, high healthcare service utilization, and high cost on patient and society. These outcomes are yet to be researched in PNG as there is currently a lack of data to substantiate patient outcomes. In addition, the cost may be different and the UK figure may not relate to PNG but gives an indication of the high financial consequences of inappropriate drug prescribing.

4.0 PRESCRIBING OF ANTIBIOTICS

The data reported in this Chapter resulted from a specific analysis of antibiotic prescribing at the three locations reported previously in Chapter 3. The demographic and general prescribing data have been reported in Tables 3.1 and 3.2. Antibiotics were selected as antibacterials (penicillins, other antibacterials, cephalosporins and other reserved antibiotics) listed in the AMH [135] and MDC [66] excluding antituberculosis, antileprosy drugs, antifungals, antivirals, antiretrovirals, antiprotozoals, and anthelmintics.

4.1 Results

Table 4.1 Antibiotic prescription according to gender and age group at each location

Variable		LHC (%) N=219	APH (%) N=185	PMGH (%) N=233	P-value
Gender	Female	106 (48.4)	89 (48.1)	112 (48.1)	0.9971
	Male	113 (51.6)	96 (51.9)	121 (51.9)	
Age group	Adult	120 (54.8)	103 (55.7)	164 (70.4)	0.0008
	Child	99 (45.2)	82 (44.3)	69 (29.6)	

The p-value compares these demographic distributions across locations.

Table 4.1 shows there were similar proportions of males and females being prescribed antibiotics at all locations (p=0.997). There was a significant difference (p=0.0008) between the frequency of prescribing for adults compared with children. This was especially due to the lower number of children that received prescribed antibiotics at PMGH (29.6%).

Table 4.2 Disease classifications for patients receiving antibiotics

Diseases	Frequency	(%)
15.4 (Acute soft tissue injuries)	126	16.3
5.5 (Malaria)	116	15.0
19 (Asthma, COPD)	110	14.2
19.5 (Cough)	75	9.7
5.1 (Bacterial infections)	38	4.9
12.1 (Dyspepsia, reflux & peptic ulcers)	38	4.9
19.1 (Bronchiolitis)	38	4.9
Others	232	30.1
Total	773	100.0

Note that subjects may have more than one diagnosis

The most common disease classifications (Table 4.2) for patients who were given prescribed antibiotics at all locations during this study were: Acute soft tissues injuries which included sores, boils, abscesses, lacerations, injuries, wounds, burns, mastioditis, backaches, fractures, and pyomyocitis. This was followed by malaria which included fever, uncomplicated malaria, severe malaria, and treatment failure malaria. It would seem possible that, because of a lack of resources for health care staff to be able to differentiate the cause of a fever, antimalarials and antibiotics were prescribed together (6.2%).

Table 4.3 Number of antibiotic items grouped according to antibiotic class prescribed at each location

Antibiotics	**LHC** (%)	**APH** (%)	**PMGH** (%)	**Total** (%)	**P-value**
Amoxicillin Products	104 (37.3)	104 (51.5)	147 (52.9)	355 (46.8)	<0.0001
Chloramphenicol	40 (14.3)	25 (12.4)	30 (10.8)	95 (12.5)	
Co-trimoxazole	49 (17.6)	24 (11.9)	22 (7.9)	95 (12.5)	
Metronidazole	32 (11.5)	11 (5.5)	17 (6.1)	60 (7.9)	
Penicillin	35 (12.5)	7 (3.5)	11 (4.0)	53 (7.0)	
Cloxacillin	8 (2.9)	18 (8.9)	23 (8.3)	49 (6.5)	
Doxycycline	5 (1.8)	2 (1.0)	9 (3.2)	16 (2.1)	
Erythromycin	1 (0.4)	7 (3.5)	6 (2.2)	14 (1.8)	
Others	5 (1.8)	4 (2.0)	13 (4.8)	22 (2.8)	
Total	279 (36.8)	202 (26.6)	278 (36.6)	759 (100.0)	

It is notable in Table 4.3 the most prescribed antibiotics during the period of this study were amoxicillin products, 37.3% at LHC, 51.5% at APH and 52.9% at PMGH. Next was chloramphenicol, 14.3% at LHC, 12.4% at APH and 10.8% at PMGH, followed by co-trimoxazole, 17.6% at LHC, 11.9% at APH and 7.9% at PMGH. Notably three antibiotics made up more than 70% of antibiotics prescribed.

Amoxicillin products included injections, syrup, capsules/tablets, and combinations with clavulanic acid. Chloramphenicol included oral capsules, eye drops, eye ointments, paediatric suspensions, injections, and combined with hydrocortisone 0.5% eye ointment. Co-trimoxazole included tablets and paediatric suspensions. Metronidazole included tablets, injections, and suppositories. Penicillin G included oral tablets, suspensions, benzathine injections and benzyl injections. Cloxacillin included flucloxacillin capsules, injections, and suspension. Doxycycline was only prescribed in tablet form. Erythromycin included tablets, injections and suspension. Others included antibiotic compound eye ointments, gentamicin, cefaclor, azithromycin, streptomycin, cephalexin, ciprofloxacin ear drops, and antibiotic ear drops.

Table 4.4 Prescribed antibiotics appropriateness by drug selection, dosage, frequency and duration by location

Parameter	Outcome	LHC (%)	APH (%)	PMGH (%)	Total (%)	P-value
Selection	Appropriate	235 (84.2)	136 (67.3)	203 (73.0)	574 (75.6)	<0.0001
	Inappropriate	44 (15.8)	66 (32.7)	75 (27.0)	185 (24.4)	
Dosage	Appropriate	218 (78.4)	192 (95.1)	274 (98.6)	684 (90.2)	<0.0001
	Inappropriate	60 (21.6)	10 (4.9)	4 (1.4)	74 (9.8)	
Frequency	Appropriate	270 (97.1)	202 (100.0)	275 (98.9)	747 (98.5)	0.0273
	Inappropriate	8 (2.9)	0 (0.0)	3 (1.1)	11 (1.5)	
Duration	Appropriate	229 (82.4)	196 (97.0)	274 (98.6)	699 (92.2)	<0.0001
	Inappropriate	49 (17.6)	6 (3.0)	4 (1.4)	59 (7.8)	
Total		278 (36.7)	202 (26.6)	278 (36.7)	758 (100.0)	

The frequency of inappropriate prescribing of antibiotics (Table 4.4) showed higher levels of inappropriate prescribing overall at LHC. It is notable that selection, dosage and duration errors were high at LHC whereas selection was the major error at the other centres.

The prescribing appropriateness of antibiotics (Tables 4.4 and 4.5) showed that approximately one quarter were inappropriate drug selections. These were made up of 23.8% when antibiotics should not have been selected for the diagnosis and 24.6% where an antibiotic type was indicated in the guidelines but a type not recommended was selected. LHC data highlights different concerns with the levels of inappropriate drug dosages and durations of treatment, being greater than for drug selection errors. The significant differences were evaluated across all the three settings.

Table 4.5 Inappropriate prescribing of antibiotics by location with 1-4 reasons

Outcome	LHC (%)	APH (%)	PMGH (%)	Total (%)	P-value
Appropriate	155 (55.5)	125 (61.9)	195 (70.1)	475 (62.6)	<0.0001
1 reason (inappropriate)	92 (33.0)	72 (35.6)	80 (28.8)	244 (32.1)	
2-4 reasons (inappropriate)	32 (11.5)	5 (2.5)	3 (1.1)	40 (5.3)	
Total	279 (36.8)	202 (26.6)	278 (36.6)	759 (100.0)	

It is notable (Table 4.5) that LHC stands out for its level of inappropriate prescribing. This arises from a combination of drug selection, dosage and duration. The application of inappropriate prescribing only required one reason for it to be deemed inappropriate. However, Table 4.5 gives an insight into the overall level of errors identified in the study.

Table 4.6 Overall inappropriate prescribing of antibiotics by location

Outcome	LHC (%)	APH (%)	PMGH (%)	Total (%)	P-value
Appropriate	155 (55.6)	125 (61.9)	195 (70.1)	475 (62.6)	0.0017
Inappropriate	124 (44.4)	77 (38.1)	83 (29.9)	284 (37.4)	
Total	279 (36.8)	202 (26.6)	278 (36.6)	759 (100.0)	

The overall inappropriate prescribing of antibiotics based upon any of the four reasons, by location, indicated a significant difference in the three locations (Table 4.6) with 44.4% at LHC and 38.1% at APH contrasting with 29.9% at PMGH.

Table 4.7 Prescribed antibiotic appropriateness for adults and children by selection, dosage, frequency and duration

Parameter	Age group	Outcome	LHC (%)	APH (%)	PMGH (%)	Total (%)	P-value
Selection	Adult	App	128 (81.0)	82 (71.3)	135 (67.2)	345 (72.8)	0.0127
		Inapp	30 (19.0)	33 (28.7)	66 (32.8)	129 (27.2)	
	Child	App	107 (88.4)	54 (62.1)	68 (88.3)	229 (80.4)	<0.0001
		Inapp	14 (11.6)	33 (37.9)	9 (11.7)	56 (19.6)	
Dosage	Adult	App	146 (93.0)	113 (98.3)	200 (99.5)	459 (97.0)	0.0010
		Inapp	11 (7.0)	2 (1.7)	1 (0.5)	14 (3.0)	
	Child	App	72 (59.5)	79 (90.8)	74 (96.1)	225 (79.0)	<0.0001
		Inapp	49 (40.5)	8 (9.2)	3 (3.9)	60 (21.0)	
Frequency	Adult	App	154 (98.1)	115 (100.0)	198 (98.5)	467 (98.7)	0.3543
		Inapp	3 (1.9)	0 (0.0)	3 (1.5)	6 (1.3)	
	Child	App	116 (95.9)	87 (100.0)	77 (100.0)	280 (98.3)	0.0318
		Inapp	5 (4.1)	0 (0.0)	0 (0.0)	5 (1.7)	
Duration	Adult	App	128 (81.5)	111 (96.5)	200 (99.5)	439 (92.8)	0.0001
		Inapp	29 (18.5)	4 (3.5)	1 (0.5)	34 (7.2)	
	Child	App	101 (83.5)	85 (97.7)	74 (96.1)	260 (91.2)	0.0003
		Inapp	20 (16.5)	2 (2.3)	3 (3.9)	25 (8.8)	

Legend: App = Appropriate Inapp = Inappropriate

In comparing adults and children (Table 4.7), relating to prescribed antibiotics by inappropriate drug selection, dosage, frequency and duration in each location, it is evident that prescribing shows less variability for adults than for children. It is evident that with the exception of drug frequency that LHC shows higher levels of inappropriate drug dosages especially for children. These would seem to indicate an inability to correctly calculate dosages at LHC.

Table 4.8 Inappropriate prescribing of antibiotics for adults and children by location

Age group	Outcome	LHC (%)	APH (%)	PMGH (%)	Total (%)	P-value
Adult	Appropriate	98 (62.0)	77 (67.0)	132 (65.7)	307 (64.8)	0.6590
	Inappropriate	60 (38.0)	38 (33.0)	69 (34.3)	167 (35.2)	
	Total	158 (33.3)	115 (24.3)	201 (42.4)	474 (100.0)	
Child	Appropriate	57 (47.1)	48 (55.2)	63 (81.8)	168 (59.0)	<0.0001
	Inappropriate	64 (52.9)	39 (44.8)	14 (18.2)	117 (41.0)	
	Total	121 (42.5)	87 (30.5)	77 (27.0)	285 (100.0)	

Any non-compliance to the guidelines of the four factors (selection, dosage, frequency, duration) is categorised as inappropriate prescribing, however these data are based upon each of these factors considered separately in Table 4.7. The data shown in Table 4.8 show similar data for adults independent of location. However, the data for children stand out for LHC with 52.9% of antibiotic prescriptions being inappropriate.

Table 4.9 Inappropriate prescribing of antibiotics with 1-4 reasons for adults and children by location

Age group	Outcome	LHC (%)	APH (%)	PMGH (%)	Total (%)	P-value
Adult	Appropriate	98 (62.0)	77 (66.9)	132 (65.7)	307 (64.8)	0.0215
	1 reason	50 (31.7)	37 (32.2)	67 (33.3)	154 (32.5)	
	2-4 reasons	10 (6.3)	1 (0.9)	2 (1.0)	13 (2.7)	
	Total	158 (33.3)	115 (24.3)	201 (42.4)	474 (100.0)	
Child	App	57 (47.1)	48 (55.2)	63 (81.8)	168 (58.9)	<0.0001
	1 reason	42 (34.7)	35 (40.2)	13 (16.9)	90 (31.6)	
	2-4 reasons	22 (18.2)	4 (4.6)	1 (1.3)	27 (9.5)	
	Total	121 (42.5)	87 (30.5)	77 (27.0)	285 (100.0)	

Legend: 1 reason = 1 reason inappropriate 2-4 reasons = 2-4 reasons inappropriate

Data in Table 4.9 show that most prescriptions assessed as inappropriate were based upon one reason, whereas a small percentage included more than one error following an application of the guidelines. It is notable that 18.2% of prescriptions at LHC included 2-4 reasons. They were classified as inappropriate based on any of these reasons.

Table 4.10 Appropriate prescribing of antibiotics with other factors of (prescriber status and correct number dispensed) by location for adults and children

Age group	Outcome	LHC (%)	APH (%)	PMGH (%)	Total (%)	P-value
Adult	Inappropriate	84 (53.2)	41 (35.6)	83 (41.3)	208 (43.9)	0.0099
	Appropriate	74 (46.8)	74 (64.4)	118 (58.7)	266 (56.1)	
	Total	158 (33.3)	115 (24.3)	201 (42.4)	474 (100.0)	
Child	Inappropriate	84 (69.4)	42 (48.3)	20 (26.0)	146 (51.2)	<0.0001
	Appropriate	37 (30.6)	45 (51.7)	57 (74.0)	139 (48.8)	
	Total	121 (42.5)	87 (30.5)	77 (27.0)	285 (100.0)	

The inappropriate prescribing of antibiotics according to other factors (prescriber status and number dispensed) and location for adults and children (Table 4.10) includes additional reasons leading to inappropriate prescribing. These other factors were whether the drug prescribed by a prescriber was in accordance with prescribing rights defined in the MDC [66], and whether the correct drug quantity supply occurred from the dispensary/pharmacy. This latter criteria was related to no supply (stock not available) to an undersupply or oversupply according to the dosage and duration prescribed.

Table 4.11 Appropriateness of prescribing antibiotics by prescriber classification based on drug selection, dosage, frequency and duration

Parameter	Prescribers	App (%)	Inapp (%)	Total (%)	P-value
Selection	CHW	71 (91.0)	7 (9.0)	78 (10.3)	0.0003
	DT/RDO/DO	13 (100.0)	0 (0.0)	13 (1.7)	
	RHEO/HEO	91 (74.0)	32 (26.0)	123 (16.2)	
	RMO/MO/SMO	277 (70.7)	115 (29.3)	392 (51.6)	
	NO	122 (79.7)	31 (20.3)	153 (20.2)	
	Total	574 (75.6)	185 (24.4)	759 (100.0)	
Dosage	CHW	64 (82.0)	14 (18.0)	78 (10.3)	<0.0001
	DT/RDO/DO	13 (100.0)	0 (0.0)	13 (1.7)	
	RHEO/HEO	102 (83.6)	20 (16.4)	122 (16.1)	
	RMO/MO/SMO	385 (98.2)	7 (1.8)	392 (51.7)	
	NO	120 (78.4)	33 (21.6)	153 (20.2)	
	Total	684 (90.2)	74 (9.8)	758 (100.0)	
Frequency	CHW	75 (96.1)	3 (3.9)	78 (10.3)	0.1714
	DT/RDO/DO	13 (100.0)	0 (0.0)	13 (1.7)	
	RHEO/HEO	121 (99.2)	1 (0.8)	122 (16.1)	
	RMO/MO/SMO	389 (99.2)	3 (0.8)	392 (51.7)	
	NO	149 (97.4)	4 (2.6)	153 (20.2)	
	Total	747 (98.5)	11 (1.5)	758 (100.0)	
Duration	CHW	64 (82.0)	14 (18.0)	78 (10.3)	<0.0001
	DT/RDO/DO	13 (100.0)	0 (0.0)	13 (1.7)	
	RHEO/HEO	109 (89.3)	13 (10.7)	122 (16.1)	
	RMO/MO/SMO	385 (98.2)	7 (1.8)	392 (51.7)	
	NO	128 (83.7)	25 (16.3)	153 (20.2)	
	Total	699 (92.2)	59 (7.8)	758 (100.0)	

Legend: App = Appropriate Inapp = Inappropriate CHW = Community Health Worker. DT = Dental Therapist RDO = Resident Dental Officer DO = Dental Officer NO = Nursing Officer RHEO = Resident Health Extension Officer HEO = Health Extension Officer RMO = Resident Medical Officer MO = Medical Officer SMO = Senior/Specialist Medical Officer

The overall inappropriateness of prescribing antibiotics by prescriber classification based on drug selection, dosage, frequency and duration is given in Table 4.11. This identifies some differences in approach by different prescribers. Medically qualified

prescribers made more inappropriate drug selections but their dosages, frequencies and durations closely followed the guidelines compared with other prescribers (non-medical) who made more inappropriate drug dosage and duration errors.

Table 4.12 Overall appropriateness of prescribing antibiotics by prescribers

Prescribers	Inapp (%)	App (%)	Total (%)	P-value
CHW	53 (68.0)	25 (32.0)	78 (10.3)	<0.0001
DT/RDO/DO	1 (7.7)	12 (92.3)	13 (1.7)	
RHEO/HEO	61 (49.6)	62 (50.4)	123 (16.2)	
RMO/MO/SMO	154 (39.3)	238 (60.7)	392 (51.6)	
NO	85 (55.6)	68 (44.4)	153 (20.2)	
Total	354 (46.6)	405 (53.4)	759 (100.0)	

Legend: Inapp = Inappropriate App = Appropriate CHW = Community Health Worker DT = Dental Therapist RDO = Resident Dental Officer DO = Dental Officer NO = Nursing Officer RHEO = Resident Health Extension Officer HEO = Health Extension Officer RMO = Resident Medical Officer MO = Medical Officer SMO = Senior/Specialist Medical Officer

Table 4.12 shows significant differences between prescriber categories and some levels of inappropriate prescribing was very high especially in the non-medical categories.

4.2 Discussion

Specific data on prescribing of antibiotics is lacking in healthcare facilities in PNG. Antibiotics have saved the lives of millions of individuals and are responsible for some of the main gains in life expectancy but, however, these gains are now gravely jeopardized by the development of bacterial resistance, partially caused by inappropriate use, of affordable, currently or previously effective first-line antibiotics [136]. Therefore, the appropriate prescription and use of antibiotics should be a priority for the reduction in the development of resistance. Inappropriate prescribing may also lead to ineffective treatment, health risks, patient non-compliance, drug wastage, wasting of resources and needless expenditure [137]. There is a clear association between antibiotic use and resistance both at the individual and population levels [138].

The study by Livermore [139] and Bronzwaer et al [140] found the evidence that antimicrobial prescribing (include inappropriate prescribing) is one of the main drivers of resistance is overwhelming, with critical observations being that acquired resistance is absent from bacteria collected before the antibiotic era, although these may have plasmids resembling the elements that nowadays host resistance genes; resistance is most prevalent in those settings such as intensive care units where antibiotic use is particularly heavy; resistant mutants are sometimes selected in individual patients during therapy, causing clinical failure; and new resistance has repeatedly emerged following introduction of new antibiotics, whether in the original target pathogens or via opportunistic species replacement in vulnerable patient groups.

On the other hand, it has been shown that appropriate prescribing of antibiotics may slow the rate at which resistance becomes widespread throughout the community. As shown by Colgan and Powers [141], it was demonstrated in Finland that erythromycin resistance among group A streptococci decreased from 16.5 to 8.6 % over a four-year period during a nationwide program relying on national guidelines to limit the use of erythromycin. In addition, other studies in the United States have shown that decreased use of antibiotics for prophylaxis and treatment correlated with decreasing rates of colonization with resistant organisms [141]. Therefore, every care should be taken to ensure that antibiotics are being prescribed appropriately.

From observations during this study and previously highlighted by Joshua and Sunderland [28], a few children were seen vomiting after being given their oral dose of medicines. Although, this wasn't the aim of this study, Baguley et al [142], found that taste and palatability affected adherence to antibiotics. If that is so, then further investigation is required to substantiate this observation. Children vomiting and not being given another dose, which was the case seen most of the time in the study settings, were actually under-dosed and may contribute to bacterial resistance.

It needs to be noted that families may have to walk for several hours, even up to a day to attend their health facilities. This makes it difficult for them to easily return if their condition deteriorates. Antibiotics may therefore be issued as a safeguard since they cannot easily return if an antibiotic was required later. This may result in overuse of antibiotics and may contribute to development of antibiotic resistance.

The leading causes of outpatient visits in 2007-2008 were; malaria, skin disease, simple cough, pneumonia, diarrhoea, other respiratory diseases, and accidents [98]. Most of these diseases would require prescribed antibiotics for treatment. Therefore, there is concurrence with these study data (Table 4.2).

4.2.1 Percentage of antibiotics prescribed at the three locations

Overall in this study, 58.4% (637/1090) of patients who were prescribed drugs received an antibiotic and at each location, the proportions of patients that received antibiotics were 61.2% at LHC, 58.2% at APH, and 56.0% at PMGH. Statistically, there appeared to be a similar proportion of patients at each location that received prescribed antibiotics (p=0.2999). This percentage is higher than the WHO/INRUD prescribing indicators, which from the period 1982-2006 has been just below 50% [35]. Prescribed antibiotics constituted 31.4% of the total drugs prescribed in all the studied locations.

A study in Yemen by Al-Shami et al. [137] , indicated an over-prescribing of antibiotics with the average percentage of antibiotics of 51.0% encounters with prescriptions and 23.8% from the total number of prescribed drugs in all the studied public hospitals' outpatients. A similarly high percentage (30-60%) was reported in a Sudan public hospital outpatient setting [143]. In addition, a higher percentage (65.0%) of antibiotic use

was recorded in the health care facilities in Ghana [144] and between 30.0% and 60.0% of the patients in primary health care centres received antibiotics in developed and the developing countries [145]. Similarly, a pilot study which was carried out in three health centres in Cambodia, showed that the percentage of antibiotics which was used ranged from 10.0% to 66.0% [146]. The percentage of patients receiving antibiotics in a District Health Centre, Hai Phong Province in Vietnam was 45% [147].

A study by Al-Niematt et al [148], in a Jordanian Hospital outpatient department found the average percentage of prescriptions involving antibiotics was 35.6% out of 187,822 prescriptions surveyed. From these, 65,500 antibiotic prescriptions were observed. In that study, penicillins (most frequently amoxicillin products) and quinolones (most frequently ciprofloxacillin and norfloxacillin) were the most commonly prescribed antibiotics with an average percentage of 31.8% and 27.5% respectively.

It is evident that although the prescribing of antibiotics in this study was high, it was also noted however that at LHC, there were few patients diagnosed with chronic diseases. The diagnoses were usually for acute conditions. However, many more patients with chronic diseases were included in the study at PMGH with only a small non-significant decrease in antibiotic prescribing.

According to WHO [35], the percentage of patients prescribed antibiotics inappropriately increased to over 50% in studies conducted between 2001 and 2006, up from 40% in earlier studies. The percentage of antibiotics prescribed in under-dosage remained over 50% in all time periods. Results suggest that inappropriate prescribing of antibiotics is a widespread problem in every geographic region. In all regions except Latin America, over 40% of reported prescriptions of antibiotics were inappropriate, with countries in South Asia having the highest rates of inappropriate antibiotic use. In Latin America, prescribing insufficient doses of antibiotics was reported more frequently than in other regions: 67% of antibiotics prescribed were dosed incorrectly.

Compared with the WHO indicator and studies outlined above, PNG is no exception where the prescribing of antibiotic drugs in the selected healthcare locations in PNG was amongst the highest levels reported internationally.

4.2.2 Prescribed antibiotics by prescribers

In PNG, apart from medical and dental officers, HEOs, Nurses, CHWs, and dental therapists are allowed to prescribe medicines for patients. Therefore as seen in this study, most of the prescribing of antibiotics at LHC was undertaken by CHWs (33.3%) and Nurses (48.0%), while Medical Doctors performed most of the prescribing at APH (67.6%) and PMGH (92.3%). About 10% of combinations of antibiotics were prescribed during the study.

The data in Table 4.11 showed that medical prescribers incurred about 29.3% inappropriate antibiotic drug selections. On the overall appropriateness of prescribing antibiotics by prescribers (Table 4.12), medical qualified staff incurred about 39.3% inappropriate prescribing. This clearly indicated that medical qualified staff do not follow the guidelines. More studies need to be done to verify this but Cabana et al. outlined a range of factors that could affect prescribers' adherence to STGs [113]. Some possibilities would be; lack of awareness, lack of familiarity, lack of self-efficacy, and environmental-related barriers.

A study by Stark et al. [149] acknowledged the contributions of nurses in the delivery of health care in rural areas of low-income countries with 50-80% of all healthcare professionals being nurses. Nurses performed roles including prescribing medications for which they may or may not have had adequate training, often in the absence of legislation and regulation [150]. This situation is reflected in PNG where most of the antibiotic prescribing at LHC which is a rural health centre was undertaken by nurses (48.0%). LHC like other regional health centres in PNG is staffed only by non-medical prescribers.

4.2.3 The choice/prescribing of antibiotics

The choice of antibiotic during prescribing is an important factor both in relation to the sensitivity of the microorganisms and to drug resistance. This study has shown (Table 4.3) that amoxicillin products, chloramphenicol and co-trimoxazole made up more than 70% of antibiotics prescribed. Therefore being knowledgeable about the pharmacology of these groups of antibiotics (including doses, spectrum of sensitivities, side effects) is

vital in the long-term for reducing the incidence of inappropriate drug prescribing and drug resistance.

According to Herzig et al. [151] and Aronson [152], education on the pathophysiology of clinical problems; on the pharmacology of the drugs used to treat them including their pharmaceutical, pharmacokinetic, and pharmacodynamic properties, and how those properties are translated into a therapeutic effect via the relevant chain of biochemical and physiological events; on adverse drug reactions and interactions; on the devising of dosage regimens; on monitoring drug therapy; and on patients' attitudes to drug therapy must be the main thrust, which is more likely to result in appropriate prescribing.

It should be noted that amoxicillin and ampicillin have similar moderate antimicrobial spectrum of activity. They commonly cause a rash which usually resolves within one week of ceasing administration [135]. Therefore, the prescriber needs to warn the patient, they may get a slight rash but don't stop the taking the antibiotic.

Chloramphenicol is usually reserved for severe typhoid/paratyphoid fever where other antibiotics are unsuitable. It may be used in patients allergic to penicillins or cephalosporins in selected cases such as meningitis, brain abscess, or acute epiglottitis and in rickettsial infections where tetracyclines are unsuitable. It can also cause serious adverse reactions. Its use requires ongoing monitoring. On the mode of action, it inhibits bacterial protein synthesis by binding to the 50S subunit of the bacterial ribosome and preventing the activity of peptidyltransferase [135].

Using the wrong antibiotics to act against a specific bacteria or a sub-standard antibiotic or administering them at an inappropriate dosing level, dosing frequency, or for a prolonged duration increases the opportunity for selection of resistant strains [153]. Guillemot et al [154] found that children treated with low daily doses of an oral ß-lactam had an increased risk of penicillin-resistant Streptococcus pneumoniae (PRSP) carriage compared with children who did not. Prolonged treatment (> 5 days) with a ß-lactam was associated with increased risk of PRSP carriage. A study by Nasrin et al [155] also showed higher PRSP in children who had taken a ß-lactam antibiotic for more than 14 days compared with a group taking no antibiotics or taking them for less than 7 days in the 6 months before nasal swabbing (26% vs 11-12%). Cohen et al. 2002 demonstrated

an increase in the MIC of S. pyogenes in 8 of 79 children with streptococcal tonsillopharyngitis treated with azithromycin 10 mg/kg/day for 3 days, who were a bacteriological failure on day 14 in an-intent to treat assessable patients. Before the treatment, the strains of S. pyogenes were susceptible to azithromycin. Their findings suggests that low dose antibiotics may promote the emergence of resistant strains, and it is the first time to that author's knowledge that macrolide resistance for S. pyogenes occurred in vivo, during antibiotic treatment.

4.2.4 Prescriber category (a factor in antibiotic prescribing)

Antibiotics like other drugs in PNG have been categorised according to the status/qualifications of health workers authorised to prescribed them [66]. A drug classified as category A means that it can be prescribed by all health workers. A category B means it can only be prescribed by a medical officer. A category C means it can only be prescribed by a senior/specialist medical officer. Shown in this study, for example, the treatment of meningitis according to the STGs is to give either chloramphenicol (capsule, suspension, or injection), which are category A items or ceftriaxone (injection), a category C item. Chloramphenicol products are available in the health centre whereas ceftriaxone injection is not.

Simple interventions such as altering order forms to reflect preferred dosing intervals for antibiotics have been successful in improving use [156]. Many hospitals limit the use of particular drugs until a nominated senior clinician has been consulted, however this can be onerous. Prescribing restrictions are a proven measure for controlling antibiotic use, but can shift practice in unforeseen ways and require efficient systems and a supportive framework to function smoothly [157].

PNG lacks the efficient systems and the supporting framework to manage the use of essential medicines effectively. Hence, the prescriber restrictions may have some impact in the use of essential medicines especially in the rural health centres where access may be limited to 87% of the population. Most of the medicines in the MDC [66] were categorised for medical officers' use only. However, there's no medical officer available at rural health centres in PNG. This leads to the conclusion that the prescriber category may be better targeted to achieve improved antibiotic prescribing outcomes.

4.2.5 Antibiotic resistance in developing countries

Antibiotic resistance is a consequence of the use, particularly the misuse of antibiotics and develops when a microorganism mutates or acquires a resistant gene [158].

It is now estimated that 50% of antimicrobial prescriptions, worldwide are associated with inappropriate use, either because of unnecessary duration of treatment, wrong selection of drug or dosage regimen, or use in persons without a discernible sign of infection [159].

It was reported by Planta [160], that resistant bacteria have emerged in many developing countries for example; in Bangladesh, over 95% of *Shigella dysenteriae* isolates were resistant to ampicillin, co-trimoxazole, and nalidixic acid, and up to 40% were resistant to mecillinam, in Quetta, Pakistan, 69% of *Salmonella typhi* isolates from blood were multidrug resistant, in tropical countries, there has been an emergence of *Streptococcus pneumoniae* that is resistant to penicillin, cefotaxime, and chloramphenicol. Furthermore, *Neisseria gonorrhoeae* has developed strains resistant to penicillin, sulfonamides, tetracyclines, and fluoroquinolones. The problem of multidrug-resistant organisms in developing countries can also directly affect and threaten more developed countries because international travel, driven by globalized trade, this allows for easier dissemination of these strains. For example, penicillin-resistant and multidrug-resistant pneumococci, like the serotype 23F clone, have been found not only in Mexico, South Africa, South Korea, and Croatia, but also in Portugal, France, and the United States [161].

4.2.6 Antibiotic resistance in PNG

Very few studies have been undertaken in PNG on the antibiotic resistance issue in relation to drug prescribing, however some related studies are outlined below:

Duke et al [87] found that when chloramphenicol was used as first line treatment for meningitis followed by ceftriaxone when in vitro resistance *was* shown, there was invariably a very poor outcome from chloramphenicol use and 71% of children died or had severe neurological complications. Using ceftriaxone as first line treatment was

effective in reducing mortality and neurological sequelae from chloramphenicol resistant *Haemophilus* influenzae type (71% *v* 9%, relative risk 0.13; 95% CI 0.02 to 0.87; p =0.013). Changing to chloramphenicol if there was no evidence of in vitro resistance was less than half the cost of empirical use of ceftriaxone for a full course for all children with meningitis.

Manning et al [88] also found that PNG children with acute bacterial meningitis, all haemophilus influenza isolates were resistant to chloramphenicol.

Duke [89] found that infections due to antibiotic-resistant bacteria, especially gram-negative bacteria, were a common cause of child mortality in Papua New Guinea. Antibiotic-resistant bacteria included the enteric gram-negative bacilli, especially Escherichia coli, Klebsiella and Enterobacter, and Haemophilus influenzae type b, a major respiratory tract pathogen and cause of meningitis. Among these bacteria there was high-level resistance to standard antibiotics, including chloramphenicol, amoxicillin and cotrimoxazole. Reasons behind the increase in antibiotic resistant bacterial infections were stated as the widespread unregulated use of antibiotics and the very large burden of bacterial infections. Risk factors for development of resistant enteric gram-negative infections included village births, prolonged hospital stay, kwashiorkor in adopted children and previous treatment with broad-spectrum antibiotics.

Lithgow and Kilalang [90] reported an outbreak of nosocomial infection caused by *Klebsiella pneumoniae* in the Special Care Nursery of Port Moresby General Hospital. In the 13 months between October 2007 and October 2008, this organism was cultured from the blood of 57 neonates, of whom 23 died, 16 of the 20 organisms cultured in the first three months were cephalosporin sensitive, but during the next ten months the proportion of sensitive organisms dropped dramatically to 10 of 37. Of the 31 multidrug-resistant organisms six were resistant to all the routinely available antibiotics.

Morewaya [91] in an unpublished report outlined that most isolates from patients at the Port Moresby General Hospital showed varying susceptibility patterns with many organisms showing multiple drug resistant patterns. Of note were coliforms showing resistance to aminoglycosides and third generation cephalosporins like ceftriaxone and

cefotaxime. Urinary coliform isolates also showed varied susceptibility to nitrofurans. Pseudomonas aeruginosa isolates showed multiple drug resistance to piperacillin, carbenicillin as well as quinolones, but was unable to be tested against carbapenems. A Salmonella typhi isolate still showed susceptibility to chloramphenicol and trimethoprim-co-trimoxazole. Haemophilus influenzae isolates showed variable susceptibility patterns to erythromycin and resistance to chloramphenicol, trimethoprim-co-trimoxazole and varied susceptibility to fluoroquinolone, ciprofloxacin. Streptococcus pneumoniae isolates showed varied susceptibility to penicillin and ceftriaxone with most isolates from sputum showing insensitivity to oxacillin. Staphylococcus aureus and MRSA isolates showed variable susceptibility with some organisms showing resistance to vancomycin. The susceptibility patterns given are from disc diffusion testing but with no minimum inhibitory concentration testing. E- test is yet to be introduced into the country. A standardisation process for culture, susceptibility testing, monitoring and reporting needs to be in place for an effective infection control strategy.

5.0 PRESCRIBING OF ANTIMALARIAL DRUGS

The data reported in this Chapter resulted from a specific analysis of antimalarial drug prescribing at the three locations reported previously in Chapter 3. The demographic and general prescribing data have been reported in Tables 3.1 and 3.2. Antimalarial drugs were deemed as antimalarials if the drug was listed in the AMH [135] and MDC [66].

5.1 Results

This study found that 32.8% (358/1090) of patients who were prescribed drugs received an antimalarial drug and within each setting, the proportions of patients that received antimalarial drugs were; 48.6% at LHC, 40.9% at APH, and 13.2% at PMGH. There was a smaller proportion of patients at PMGH receiving antimalarial drugs than at the other centres ($p<0.0001$).

Table 5.1 Prescribed antimalarial drug use according to gender and age group at each location

Variable	LHC (%) N=173	APH (%) N=130	PMGH (%) N=55	p-value
Gender				0.0128
Male	68 (39.3)	39 (30.0)	29 (52.7)	
Female	105 (60.7)	91 (70.0)	26 (47.3)	
Age group				0.85
Adult	105 (60.7)	77 (59.2)	35 (63.6)	
Child	68 (39.3)	53 (40.8)	20 (36.4)	

The p-value compares these demographic distributions across locations

There was a significantly lower proportion of males treated in LHC and APH compared to PMGH (Table 5.1). In comparing adults and children, there were similar proportions in each location.

Table 5.2 PNG STGs disease classifications for patients that received prescribed antimalarial drugs

Disease	Frequency	(%)
5.5 (Malaria)	299	56.3
7.5 (Anaemia)	102	19.2
19 (Asthma, COPD)	43	8.1
19.5 (Cough)	17	3.2
15.4 (Acute soft tissue injuries)	12	2.3
Others	58	10.9
Total	531	100.0

Note that patients may have more than one prescribers' diagnosis

There were 531 diagnoses for the 358 patients that received antimalarial drugs. Patients were also prescribed antibiotics together with antimalarial drugs for these diseases (Table 5.2). In this study, a total of 13.2% dosage forms (144/1090) were for all malaria cases (UCM, SM & TFM) and of these, 12.7% dosage forms (138/1090) of cases were for uncomplicated malaria (UCM).

Table 5.3 Number of antimalarial drugs grouped according to antimalarial drug class prescribed at each location

Drug	LHC **(%)**	APH **(%)**	PMGH **(%)**	Total **(%)**	P-value
Arthemeter/Artesunate	41 (16.0)	78 (48.8)	67 (60.9)	186 (35.4)	<0.0001
Chloroquine	107 (41.8)	52 (32.5)	3 (2.7)	162 (30.8)	
Sulphadoxine-pyrimethamine	69 (27.0)	29 (18.1)	28 (25.5)	126 (23.9)	
Amodiaquine	39 (15.2)	1 (0.6)	12 (10.9)	52 (9.8)	
Total	256 (48.7)	160 (30.4)	110 (20.9)	526 (100.0)	

Note: The numbers in the table are the number of prescriptions for each drug or combination and each patient may be prescribed more than one antimalarial drug or combination

There are notable differences in antimalarial drug prescribing dependent on location. Arthemeter/Artesunate (Table 5.3) included oral tablets, and injections. These were prescribed in the highest prevalence at PMGH. Chloroquine, sulphadoxine-pyrimethamine and amodiaquine included only oral tablets.

Table 5.4 Prescribed antimalarial drugs appropriateness based on drug selection, dosage, frequency, and duration by location

Parameter	Outcome	LHC **(%)**	APH **(%)**	PMGH **(%)**	Total **(%)**	P-value
Selection	Appropriate	253 (98.8)	83 (51.9)	44 (40.0)	380 (72.2)	<0.0001
	Inappropriate	3 (1.2)	77 (48.1)	66 (60.0)	146 (27.8)	
Dosage	Appropriate	205 (80.1)	136 (85.0)	105 (95.5)	446 (84.8)	0.0009
	Inappropriate	51 (19.9)	24 (15.0)	5 (4.6)	80 (15.2)	
Frequency	Appropriate	252 (98.4)	160 (100.0)	110 (100.0)	522 (99.2)	0.1194
	Inappropriate	4 (1.6)	0 (0.0)	0 (0.0)	4 (0.8)	
Duration	Appropriate	245 (95.7)	159 (99.4)	102 (92.7)	506 (96.2)	0.0165
	Inappropriate	11 (4.3)	1 (0.6)	8 (7.3)	20 (3.8)	
Total		256 (48.7)	160 (30.4)	110 (20.9)	526 (100.0)	

Data in Table 5.4 show high levels of inappropriate prescribing with up to 60% of inappropriate selections of antimalarial drugs at PMGH. Wrong dosage calculations occurred more frequently at LHC and APH.

Table 5.5 Inappropriate prescribing of antimalarial drugs by location with one to four reasons

Outcome	LHC (%)	APH (%)	PMGH (%)	Total (%)	P-value
Appropriate	198 (77.3)	65 (40.6)	40 (36.4)	303 (57.6)	<0.0001
1 reason inappropriate	49 (19.1)	88 (55.0)	61 (55.5)	198 (37.6)	
2-4 reasons inappropriate	9 (3.5)	7 (4.4)	9 (8.2)	25 (4.8)	
Total	256 (48.7)	160 (30.4)	110 (20.9)	526 (100.0)	

Data in Table 5.5 indicates that prescriptions were usually classified as inappropriate based on a single criterion however, a small number contained more than one reason for being classified as inappropriate. Low levels of appropriate outcomes occurred at APH and PMGH. The findings are summarised in Table 5.6 which shows a significantly better prescribing appropriateness at LHC compared with APH and PMGH ($p<0.0001$).

Table 5.6 Overall Inappropriate prescribing of antimalarial drugs by location

Outcome	LHC (%)	APH (%)	PMGH (%)	Total (%)	P-value
Appropriate	198 (77.3)	65 (40.6)	40 (36.4)	303 (57.6)	<0.0001
Inappropriate	58 (22.7)	95 (59.4)	70 (63.6)	223 (42.4)	
Total	256 (48.7)	160 (30.4)	110 (20.9)	526 (100.0)	

Table 5.7 Prescribed antimalarial drug appropriateness by drug selection, dosage, frequency and duration for adults and children

Parameter	Age group	Outcome	LHC **(%)**	APH **(%)**	PMGH **(%)**	Total **(%)**	P-value
Selection	Adult	Appropriate	139 (99.3)	67 (72.0)	26 (31.7)	232 (73.6)	<0.0001
		Inappropriate	1 (0.7)	26 (28.0)	56 (68.3)	83 (26.4)	
	Child	Appropriate	114 (98.3)	16 (23.9)	18 (64.3)	148 (70.1)	<0.0001
		Inappropriate	2 (1.7)	51 (76.1)	10 (35.7)	63 (29.9)	
Dosage	Adult	Appropriate	115 (82.1)	76 (81.7)	78 (95.2)	269 (85.4)	0.0149
		Inappropriate	25 (17.9)	17 (18.3)	4 (4.9)	46 (14.6)	
	Child	Appropriate	90 (77.6)	60 (89.5)	27 (96.4)	177 (83.9)	0.0161
		Inappropriate	26 (22.4)	7 (10.5)	1 (3.6)	34 (16.1)	
Frequency	Adult	Appropriate	139 (99.3)	93 (100.0)	82 (100.0)	314 (99.7)	0.5342
		Inappropriate	1 (0.7)	0 (0.0)	0 (0.0)	1 (0.3)	
	Child	Appropriate	113 (97.4)	67 (100.0)	28 (100.0)	208 (98.6)	0.2876
		Inappropriate	3 (2.6)	0 (0.0)	0 (0.0)	3 (1.4)	
Duration	Adult	Appropriate	136 (97.1)	93 (100.0)	77 (93.9)	306 (97.1)	0.0540
		Inappropriate	4 (2.7)	0 (0.0)	5 (6.1)	9 (2.9)	
	Child	Appropriate	109 (94.0)	66 (98.5)	25 (89.3)	200 (94.8)	0.1534
		Inappropriate	7 (6.0)	1 (1.5)	3 (10.7)	11 (5.2)	

Data in Table 5.7 shows the comparison between adults and children with regard to inappropriate prescribing of antimalarial drugs. On drug selection, it ranges from 28%-68.3% for adults while for children, it ranges from 35.7%-76.1%. On drug dosage, 17.9%-18.3% for adults and 10.5%-22.4% for children.

Table 5.8 Inappropriate prescribing of antimalarial drugs for adults and children

Age group	Outcome	LHC **(%)**	APH **(%)**	PMGH **(%)**	Total **(%)**	P-value
Adult	Appropriate	111 (79.3)	50 (53.8)	23 (28.1)	184 (58.4)	<0.0001
	Inappropriate	29 (20.7)	43 (46.2)	59 (71.9)	131 (41.6)	
	Total	140 (44.4)	93 (29.5)	82 (26.0)	315 (100.0)	
Child	Appropriate	87 (75.0)	15 (22.4)	17 (60.7)	119 (56.4)	<0.0001
	Inappropriate	29 (25.0)	52 (77.6)	11 (39.3)	92 (43.6)	
	Total	116 (55.0)	67 (31.7)	28 (13.3)	211 (100.0)	

Table 5.8 show the frequency of prescribed antimalarial drugs for adults compared with children. The inappropriate prescribing of antimalarial drugs for adults was 20.7% at LHC, 46.2% at APH, and 71.9% at PMGH. For children, it was 25% at LHC, 77.6% at APH, and 39.3% at PMGH. There was a significant differences in inappropriate prescribing with respect to location for both adults and children.

Table 5.9 Inappropriateness of prescribing of antimalarial drugs with one to four reasons for adults and children

Age group	Outcome	LHC **(%)**	APH **(%)**	PMGH **(%)**	Total **(%)**	P-value
Adult	Appropriate	111 (79.3)	50 (53.8)	23 (28.1)	184 (58.4)	<0.0001
	1 reason	27 (19.3)	43 (46.2)	53 (64.6)	123 (39.1)	
	2-4 reasons	2 (1.4)	0 (0.0)	6 (7.3)	8 (2.5)	
	Total	140 (44.4)	93 (29.5)	82 (26.0)	315 (100.0)	
Child	Appropriate	87 (75.0)	15 (22.4)	17 (60.7)	119 (56.4)	<0.0001
	1 reason	22 (19.0)	45 (67.2)	8 (28.6)	75 (35.5)	
	2-4 reasons	7 (6.0)	7 (10.5)	3 (10.7)	17 (8.1)	
	Total	116 (55.0)	67 (31.7)	28 (13.3)	211 (100.0)	

Legend: 1 reason = 1 reason inappropriate 2-4 reasons = 2-4 reasons inappropriate

Table 5.9 further showed the frequency of inappropriate prescribing of antimalarial drugs based on one reason and two-four reasons comparing adults and children. The data indicate that prescriptions were classified as inappropriate mainly on one rather than multiple criteria.

Table 5.10 Appropriateness of prescribing and rational use of antimalarial drugs by location with other factors* for adults and children

Age group	Outcome	LHC **(%)**	APH **(%)**	PMGH **(%)**	Total **(%)**	P-value
Adult	Inappropriate	54 (38.6)	41 (44.1)	59 (71.9)	154 (48.9)	<0.0001
	Appropriate	86 (61.4)	52 (55.9)	23 (28.1)	161 (51.1)	
	Total	140 (44.4)	93 (29.5)	82 (26.0)	315 (100.0)	
Child	Inappropriate	48 (41.7)	53 (79.1)	11 (39.3)	112 (53.3)	<0.0001
	Appropriate	67 (58.3)	14 (20.9)	17 (60.7)	98 (46.7)	
	Total	115 (54.8)	67 (31.9)	28 (13.3)	210 (100.0)	

*Other factors were the prescriber category was according to the legislation and the supply not in accordance with prescription requirements.

The overall frequency of inappropriate prescribing of antimalarial drugs with other factors (prescriber category and drug quantity dispensed) for adults (Table 5.10) was 38.6% at LHC, 44.1% at APH and 48.9% at PMGH. For children, it was 41.7% at LHC, 79.1% at APH, and 39.3% at PMGH. These other factors were; pharmacy supply not in accordance with prescription requirements where they were either not supplied, under-supplied, or over-supplied, and category of the prescription not according to legislative restrictions on non-medical prescribers as listed in the PNG essential drug list (MDC, 2002).

Table 5.11 Appropriateness of prescribing antimalarial drugs by prescriber classification based on drug selection, dosage, frequency and duration

Parameter	Prescribers	Appropriate **(%)**	Inappropriate **(%)**	Total **(%)**	P-value
Selection	CHW	97 (99.0)	1 (1.0)	98 (18.6)	<0.0001
	RHEO/HEO	22 (45.8)	26 (54.2)	48 (9.1)	
	RMO/MO/SMO	51 (30.4)	117 (69.6)	168 (31.9)	
	NO	210 (99.1)	2 (0.9)	212 (40.3)	
	Total	380 (72.2)	146 (27.8)	526 (100.0)	
Dosage	CHW	77 (78.6)	21 (21.4)	98 (18.6)	0.0009
	RHEO/HEO	42 (87.5)	6 (12.5)	48 (9.1)	
	RMO/MO/SMO	157 (93.5)	11 (6.5)	168 (31.9)	
	NO	170 (80.2)	42 (19.8)	212 (40.3)	
	Total	446 (84.8)	80 (15.2)	526 (100.0)	
Frequency	CHW	96 (98.0)	2 (2.0)	98 (18.6)	0.2749
	RHEO/HEO	48 (100.0)	0 (0.0)	48 (9.1)	
	RMO/MO/SMO	168 (100.0)	0 (0.0)	168 (31.9)	
	NO	210 (99.1)	2 (0.9)	212 (40.3)	
	Total	522 (99.2)	4 (0.8)	526 (100.0)	
Duration	CHW	95 (96.9)	3 (3.1)	98 (18.6)	0.6100
	RHEO/HEO	46 (95.8)	2 (4.2)	48 (9.1)	
	RMO/MO/SMO	159 (94.6)	9 (5.4)	168 (31.9)	
	NO	206 (97.2)	6 (2.8)	212 (40.3)	
	Total	506 (96.2)	20 (3.8)	526 (100.0)	

Legend: CHW=Community Health Worker. RHEO=Resident Health Extension Officer. HEO=Health Extension Officer. RMO=Resident Medical Officer. MO=Medical Officer. SMO=Specialist Medical Officer. NO=Nursing Officer.

The frequency of inappropriate prescribing of antimalarial drugs (Table 5.11) based on drug selection by MO was 69.6% and HEO at 54.2%. On drug dosage, CHW was 21.4% and NO at 19.8%. There was a significant difference ($p<0.0001$) observed between the prescribers for drug selection and drug dosage categories ($p=0.0009$).

Table 5.12 Overall appropriateness of prescribing by category of prescribers

Prescribers	Inappropriate **(%)**	Appropriate **(%)**	Total **(%)**	P-value
CHW	44 (44.9)	54 (55.1)	98 (18.7)	<0.0001
RHEO/HEO	36 (75.0)	12 (25.0)	48 (9.1)	
RMO/MO/SMO	122 (72.6)	46 (27.4)	168 (32.0)	
NO	64 (30.3)	147 (69.7)	211 (40.2)	
Total	266 (50.7)	259 (49.3)	525 (100.0)	

Table 5.12 showed marked differences in the overall inappropriate prescribing of antimalarial drugs by different prescriber categories. Overall appropriateness includes the prescriber meets the legislative requirements for prescribing the drug and the supply was in accordance with the drug ordered and the duration of the prescription.

5.2 Discussion

Malaria remains an important public health concern in PNG where transmission occurs regularly and each year about 600-700 people are reported to die from malaria [98]. The population at risk is increasing due to issues such as drug resistance, unavailability of treatment, inaccessibility to health services, large movements of populations from non-malarious areas to malaria endemic areas and global warming. Malaria diagnosis in all PNG health facilities is mostly based on clinical signs and symptoms resulting in gross over-diagnosis and over-treatment[162].

According to the PNG National Health Plan 2011-2020 [98], the leading causes of outpatient visits in 2007-2008 was malaria. This data is similar to the data collected in this study (Table 5.2) where there were 299 cases of malaria alone and malaria was the most frequent diagnosis. There were a total of 531 of cases when combined with other diseases.

This confirms that malaria is one of the major diseases prevalent in PNG and efforts must be undertaken to control its spread and to minimise problems of resistance of the parasites to antimalarial products. This study highlights some issues relating to antimalarial drug prescribing and promotes ways to improve how drugs are prescribed appropriately in line with the PNG STGs. This study demonstrated that it is essential for all health workers to play their part in reducing the incidence of resistance/inappropriate antimalarial drug prescribing.

5.2.1 Prescribed antimalarial drugs by prescriber categories

Most of the prescribing of antimalarial drugs at LHC was undertaken by CHWs (35.3%) and Nurses (61.3%), while medical doctors performed most of the prescribing at APH (40.8%) and PMGH (89.1%). When the prescribers were grouped into medical and non-medical, the non-medical group prescribing of antimalarials was 100% at LHC, 59.2% at APH, and 10.9% at PMGH. A study by Joshua and Sunderland (2008) found that the majority of prescribing was performed by nurses (94.3%), HEOs (4.0%) and doctors (1.7%) at urban clinics in National Capital District of PNG. This current study confirms the continued employment of non-medical prescribers at health centres. It is evident

from the data that different prescriber categories require different education strategies to address the current issues. Medical prescribers make less selections according to guidelines but non-medical prescribers have difficulty with dosage calculations especially for children.

5.2.2 Poly-pharmacy

The mean number of antimalarial products prescribed per patient was one at LHC and APH, while it was approximately two at PMGH. In Ghana, Abuaku et al [96] found the mean number of malaria drugs prescribed per encounter was 4.3 and 3.0 in the Wassa West and Kassena Nankana districts respectively. The standard treatment guidelines usually only recommend a single drug or a combination in the one dosage form. It is unclear whether the higher numbers found in Ghana included combination medications in the one dosage form separately counted as medication numbers.

5.2.3 Common diseases where antimalarial drugs were prescribed

The drugs prescribed were classified according to the disease classifications for these drugs contained in the PNG STGs (Table 5.2) and the actual prescribers' diagnoses used in this study are expanded below under each main diagnosis: Malaria includes fever, uncomplicated malaria (UCM), severe malaria (SM) and treatment failure malaria (TFM). Anaemia includes iron deficiency, lethargy, and dyspnoea. Asthma and COPD (chronic obstructive pulmonary disease) includes influenza, pneumonia, and upper respiratory tract infections. Cough includes simple cough. Acute soft tissues injuries includes sores, boils, abscesses, lacerations, injuries, wounds, burns, mastioditis, backaches, fractures, and pyomyocitis.

It is notable that antimalarial drugs were prescribed when other infections were also suspected. As no independent accuracy of diagnosis could be obtained, it was unclear whether this is an inability to make an accurate diagnosis or patients had multiple illnesses. It may be that the cause of fever was not at that stage definitely only malaria. No diagnostic tests were carried out for malaria at LHC or APH and it was unknown whether any were conducted at PMGH. A study by Oshikoya [95] at a paediatric outpatient clinic of the Lagos State University Teaching Hospital showed that only (0.7%) 23/3500 of the patients (children) were investigated (diagnostic tests were

carried out for malaria) and confirmed to have malaria before being prescribed antimalarial drugs. In a healthcare setting, when no specific diagnostic tests were carried out for malaria, creates the situation where a misdiagnosis can occur, or misuse of drugs occurred and a possibility, this may lead to drug resistance and waste of resources as well as possible unnecessary adverse effects.

5.2.4 Antimalarial drugs prescribed at each location

The most prescribed antimalarial drug (Table 5.3) at APH and PMGH were arthemeter/artesunate at 48.8% and 60.9% respectively. Chloroquine was 41.8% at LHC and 32.5% at APH while sulphadoxine-pyrimethamine was 27% at LHC, 18.1% at APH and 25.5% at PMGH. It is notable that significantly different prescribing patterns occurred at each location ($p<0.0001$)

More than one antimalarial drug or antimalarial dosage form was sometimes prescribed for the same patient. According to the PNG STGs used during this study period in 2010, the antimalarial dosage form for the treatment of UCM in adults was chloroquine plus sulphadoxine-pyrimethamine. For SM, the treatment was artemether injection, artesunate tablets, sulphadoxine-pyrimethamine, and quinine injection. For TFM, the drug choice was artesunate tablets, artemether injection, and quinine tablets.

For the treatment of UCM in children the recommended treatment was amodiaquine or chloroquine plus sulphadoxine-pyrimethamine. For the treatment of SM was artemether injection, artesunate tablets, sulphadoxine-pyrimethamine, quinine injection, and quinine tablets. For the treatment of TFM was artesunate tablets and sulphadoxine-pyrimethamine.

The frequency of prescribing for these in this study were; 12.0% for arthemeter/artesunate and sulphadoxine-pyrimethamine, 13.1% for chloroquine and sulphadoxine-pyrimethamine; and 31.6% for amodiaquine and sulphadoxine-pyrimethamine. These antimalarial drug dosage forms were in accordance with the standard treatment guidelines used during the time when this study was undertaken in 2010. However, 12.0% was recorded for arthemeter/artesunate and sulphadoxine-pyrimethamine given in treatment of UCM. This indicated that arthemeter/artesunate

was wrongly given for treatment of UCM which is not in line with the PNG STGs. This is a very serious issue and definitely will lead to drug resistance.

A recent study by Bashrahil et al [93] at two state owned hospital outpatients clinics in Yemen, found that chloroquine was the most commonly prescribed antimalarial (42.9% of prescriptions) of the 42 prescriptions investigated, with quinine the second most prescribed (31.0%), Sulfadoxine-pyrimethamine, halofantrine and artemether were prescribed in 4.8%, 2.4% and 2.4% of prescriptions respectively. The remaining seven prescriptions had combinations of more than one antimalarial: chloroquine plus sulfadoxine-pyrimethamine in five cases and quinine plus sulfadoxine-pyrimethamine in two cases. This shows a wider range of selections than used in PNG with chloroquine and quinine the usual treatment options in that country in a similar time frame to this study.

In South-East Nigeria, Meremikwu et al [94] conducted the study in a sample of 13 health facilities situated in rural and urban areas found chloroquine to be the most common prescribed drug (30.2%), followed by sulphadoxine-pyrimethamine (22.7%), and artemisinin alone (15.8%). Monotherapy was 77% of all prescriptions and combination therapy was 20.8% of all prescriptions (665) and the commonest combination treatment was chloroquine with sulphadoxine-pyrimethamine.

In Lagos, Nigeria, a study by Oshikoya [95] involving children attended to at the paediatric general outpatient clinic at Lagos State University Teaching Hospital found that artemesinin based combination drugs constituted 26.2% of all the antimalarial drugs prescribed followed by sulphadoxine-pyrimethamine 564 (20.0%). This earlier study showed a much higher level of artemesinin based drugs.

In Ghana, Abuaku et al [96] conducted a study in the Wassa West and the Kassena Nankana districts, found that chloroquine was the most commonly prescribed antimalarial and the proportion of prescriptions containing chloroquine was significantly higher from 84.2%-97% while other antimalarial drugs prescribed were amodiaquine (5%-15%), sulphadoxine-pyrimethamine (1.3%-4%), artemisinin (1%-5.8%) and quinine (1.8%). This study shows that chloroquine was the mainstay of treatment and few other antimalarial prescribed. This is notably different to the findings of this study.

5.2.5 Prescribing of antimalarial drugs

This study has found a low level of prescribing compliance with the guidelines that were in place when the study was carried out. With malaria treatment being so common in PNG it is important that standard treatment guidelines are adhered to. In addition there is a high level of treatment of malaria when another infection is also suspected requiring antibiotics. This may lead to some unnecessary prescribing of antimalarials which can cause adverse drug effects and higher levels of resistance. The frequency of appropriate prescribing of antimalarial drugs (Table 5.4) in the three locations was based on drug selection, dosage, frequency and duration. There were significant differences across the three locations with regards to drug selection ($p<0.0001$) and dosage ($p=0.0009$). Most of the inappropriate drug selection was at APH and PMGH whereas dosage was a notable factor at LHC and APH.

Bashrahil et al [93] found only around one-half of the prescriptions (54.8%) were compliant with the NMCP treatment guidelines for appropriate dose and duration. Of the 19 noncompliant prescriptions, duration of treatment was the most common error in prescribing (63.2%), while incorrect dose was much rarer (5.3%); errors in both dose and duration were found on 31.6% of prescriptions. These finding are similar to those found in this study with the exception of lower levels of dosage errors.

5.2.6 Comparison of adults and children receiving prescribed antimalarial drugs

In comparing adults and children (Table 5.7), regarding prescribed antimalarial drugs by inappropriate drug selection, dosage, frequency and duration in each location, it is evident that drug selection and dosage shows significant differences ($p<0.05$) for adults and children across the centres evaluated. The results show that with the exception of drug frequency and duration, APH and PMGH showed higher levels of inappropriate drug selection for both adults and children. These would seem to indicate an inability by prescribers to correctly select antimalarial drugs according to the PNG standard treatment guidelines. There is a significant difference shown for drug dosages for adults and children with higher levels recorded at LHC and APH. This indicated the prescribers' inability to calculate dosages in adults and children. It would be known to particularly medical prescribers that artesunate products were being used elsewhere

and could be made available through local hospital discretionary funding. This may have given rise to some of the inappropriate selection found with medical prescribers.

5.2.7 Antimalarial drug resistance

As commented by Bloland [92], antimalarial drug resistance has emerged as one of the greatest challenges facing malaria control today. Drug resistance has been implicated in the spread of malaria to new areas and re-emergence of malaria in areas where the disease had been eradicated. Drug resistance has also played a significant role in the occurrence and severity of epidemics in some parts of the world. Population movement has introduced resistant parasites to areas previously free of drug resistance.

There is concern over the emergence and possible spread of Plasmodium falciparum resistance to artemisinins [163]. In January 2011, the Global Plan for Artemisinin Resistance Containment (GPARC) was released to outline the actions required to deal with the threat of artemisinin resistance and to reiterate the key points from the GPARC, provide background and updates on the current situation of artemisinin resistance in affected countries in the Mekong region, and summarize current activities and recommended further action where needed. With artemisinin products only released for general treatment with revised guidelines in 2011 it is too early to know whether resistance has occurred in PNG [163].

White [164] reported that *P. falciparum* was now highly resistant to chloroquine in most malaria-affected areas. Resistance to sulphadoxine-pyrimethamine was also widespread and has developed much more rapidly. Resistance to mefloquine was confined only to those areas where it has been used widely (Thailand, Cambodia, and Vietnam) but has arisen within six years of systematic deployment. The epidemiology of resistance in *Plasmodium vivax* is less well studied; chloroquine resistance is serious only in parts of Indonesia, Papua New Guinea, and adjacent areas. Sulphadoxine-pyrimethamine resistance in *P. vivax* is more widespread.

5.2.8 Studies and state of antimalarial drugs in PNG

A number of studies on the susceptibility of *P. falciparum* to chloroquine and other currently used antimalarial drugs have been carried out in Papua New Guinea, where

the standard first-line treatment for falciparum malaria and clinically diagnosed malaria is chloroquine for those aged five years and above and amodiaquine for children under 5 years [99]. These studies have shown 51% R1 (resistance level 1), 22% R2 (resistance level 2) and 14% R3 (resistance level 3) level resistance to chloroquine in East New Britain Province. In Madang Province there was 42-46% R1, 3-4% R2 and 2-4% R3 resistance to chloroquine. In Western Province chloroquine resistance was 33% R1, 10% R2 and 3% R3. The level of resistance to amodiaquine was 22-24% and to quinine was 7% in the Madang and East Sepik provinces. These findings are of concern as they relate to the drugs recommended in the standard treatment guidelines current in 2010. These finding could impact on the level of inappropriate selections found in the study. It also highlights a possibility that the guidelines were considered out of date by some prescribers.

The study by Nsanzabana et al [100] at a rural health centre in PNG showed that with the high levels of resistance to chloroquine (CQ), amodiaquine (AQ), and sulphadoxine-pyrimethamine (SP), the deployment of the combination of both drugs (CQ plus SP or AQ plus SP) appears to increase clinical effectiveness but does not decelerate growth of resistance.

6.0 PNG ESSENTIAL MEDICINES LIST compared with STANDARD TREATMENT GUIDELINES

The data reported in this Chapter have resulted from the specific recording of drugs prescribed at the three locations reported previously in Chapter three. This indicated that some inconsistencies were evident between prescribed drugs listed in the PNG standard treatment guidelines (STGs) and the Medical and Dental Catalogue (MDC) [66]. This was further reinforced with the data reported in Chapters four and five. It should be noted that the MDC is the Essential Medicines List for PNG [109].

6.1 Results

Table 6.1.1a Drugs for treatment of malaria

STG	Dosage form	Strength	MDC	Dosage form	Strength	Cat	HCOF
Amodiaquine	Tab	100mg	Amodiaquine	Tab	100mg	A	A
Artemether, IM Inj, 80mg/ml	Inj	80mg	Artemether, IM Inj, 80mg/ml	Inj	80mg	A	NA
Artemether, IM Inj, 40mg/ml	Inj	40mg	Artemether, IM Inj, 40mg/ml	Inj	40mg	A	NA
Artesunate	Tab	50mg	Artesunate	Tab	50mg	A	NA
Chloroquine	Tab	150mg	Chloroquine	Tab	150mg	A	A
Primaquine	Tab	7.5mg	Primaquine	Tab	7.5mg	A	A
Quinine	Inj	120mg	Quinine	Inj	120mg	B	A
Quinine	Inj	600mg	Quinine	Inj	600mg	B	A
Quinine	Tab	300mg	Quinine	Tab	300mg	B	A
Sulphadoxine-pyrimethamine	Tab	500mg/ 25mg	Sulphadoxine-pyrimethamine	Tab	500mg/ 25mg	A	A
Chloramphenicol	Inj	1g	Chloramphenicol	Inj	1g	A	A
Ceftriaxone	Inj	1g	Ceftriaxone	Inj	1g	C	NA
Promethazine	Tab	25mg	Promethazine	Tab	25mg	A	A
Doxycycline	Tab	100mg	Doxycycline	Tab	100mg	A	A

STG=Standard treatment guidelines. MDC=Medical & Dental Catalogue. HCOF=Health Centre Order Form (A=Available, NA=Not available). Cat=Prescribers drug prescribing categories (A=All health workers, B=Medical Officers only, C=Specialist Medical Officers only as listed in MDC)

Table 6.1.1a shows the antimalarial drugs listed in the PNG STGs, MDC and HCOF including the prescribing legislation categories. Artemether injections and artesunate tablets are category A items but were not listed in the HCOF. Quinine injections and

tablets are category B items, yet they were listed in the HCOF. Ceftriaxone injection is a category C item for treatment of meningitis and was not listed in the HCOF.

Table 6.1.1b Malaria drug treatments for adults and children as listed in the STGs

Malaria	Adults/Drugs	Children/Drugs	MDC
UCM	Chloroquine Tab, 150mg	Chloroquine Tab, 150mg	A
		Amodiaquine Tab, 100mg	A
	Promethazine Tab, 25mg (give if itch is severe		A
	Artesunate Tab, 50mg (give if skin rash develop & stop chloroquine)		A
	Sulphadoxine-pyrimethamine Tab, 500mg/25mg	Sulphadoxine-pyrimethamine Tab, 500mg/25mg	A
TFM	Artesunate Tab, 50mg	Artesunate Tab, 50mg	A
		Sulphadoxine-pyrimethamine Tab, 500mg/25mg	A
	Artemether, IM Inj, 80mg/ml (give if patient is vomiting/can't take oral medication)		A
	Quinine Tab, 300mg (give if artesunate is not available		A
	Quinine Tab, 300mg	Quinine Tab, 300mg	A
	Quinine Inj, 600mg (give if patient very sick)		A
SM	Artemether, IM Inj, 80mg/ml (give if patient very sick)	Artemether, IM Inj, 80mg/ml	A
	Artesunate Tab, 50mg (give when patient is able to drink)	Artesunate Tab, 50mg	A
	Sulphadoxine-pyrimethamine Tab, 500mg/25mg	Sulphadoxine-pyrimethamine Tab, 500mg/25mg	A
		Artemether, IM Inj, 40mg/ml	A
	Quinine Inj, 600mg (give if artemether is not available)		A
		Quinine Inj, 120mg	A
	Quinine Tab, 300mg (give only when patient improves)	Quinine Tab, 300mg	A
MP	Chloroquine Tab, 150mg	Chloroquine Tab, 150mg	A
		Amodiaquine Tab, 100mg	A
	Sulphadoxine-pyrimethamine Tab, 500mg/25mg		A
	Doxycycline Tab, 100mg		A
	Artesunate Tab, 50mg		A
CM		Sulphadoxine-pyrimethamine Tab, 500mg/25mg	A
		Artesunate Tab, 50mg	A
		Artemether, IM Inj, 80mg/ml	A
		Artemether, IM Inj, 40mg/ml	A
		Chloramphenicol Inj, 1g	A
		Ceftriaxone Inj, 1g	A

UCM=Uncomplicated malaria. TFM=Treatment failure malaria. SM=Severe malaria. MP=Malaria prophylaxis. CM=Cerebral malaria. MDC=Medical and Dental Catalogue (A=Available, NA=Not Available)

Table 6.1.1b lists the different treatments for malaria episodes listed in the STGs for both adults and children.

Table 6.1.2a Drugs for treatment of anaemia in PNG

STG	Dosage form	Strength	MDC	Dosage form	Strength	Cat	HCOF
Ferrous sulphate-folic Acid	Tab	200mg/25mcg	Ferrous sulphate-folic Acid	Tab	200mg/25mcg	A	A
Albendazole	Tab	200mg	Albendazole	Tab	200mg	A	A
Folic Acid	Tab	5mg	Folic Acid	Tab	5mg	A	NA
Iron	Inj	5ml	Iron Dextran	Inj	5ml	A	NA
Iron	Inj	2ml	Iron Dextran	Inj	2ml	A	A
Ferrous fumarate	Susp	46mg/5ml					NA
Iron Mixture (Infant)	Syrup	300mg/5ml	Iron Mixture (Infant)	Syrup	300mg/5ml	A	NA
Frusemide	Inj	20mg/2ml	Frusemide	Inj	20mg/2ml	A	NA
Chloroquine	Tab	150mg	Chloroquine	Tab	150mg	A	A
Sulphadoxine-pyrimethamine	Tab	500mg/25mg	Sulphadoxine-pyrimethamine	Tab	500mg/25mg	A	A
Amodiaquine	Tab	100mg	Amodiaquine	Tab	100mg	A	A
Promethazine	Tab	25mg	Promethazine	Tab	25mg	A	A
			Folic Acid	Inj	15mg/ml	C	NA
			Hydroxyco-balamine	Inj	1mg	C	NA

STG=Standard treatment guidelines. MDC=Medical & Dental Catalogue. HCOF=Health Centre Order Form (A=Available, NA=Not available). Cat=Prescribers drug prescribing categories (A=All health workers, B=Medical Officers only, C=Specialist Medical Officers only as listed in MDC)

Table 6.1.2a shows the drug treatment for anaemia listed in the PNG STGs, MDC and HCOF form including the prescribing legislation categories.

Table 6.1.2b Drug treatment for anaemia for adults and children as listed in the STGs

Disease	Adults Drugs	Children Drugs	MDC
Anaemia	Ferrous sulphate-folic Acid Tab, 200mg/25mcg	Ferrous sulphate-folic Acid Tab, 200mg/25mcg	A
	Chloroquine Tab, 150mg	Chloroquine Tab, 150mg	A
	Sulphadoxine-pyrimethamine Tab, 500mg/25mg	Sulphadoxine-pyrimethamine Tab, 500mg/25mg	A
		Amodiaquine Tab, 100mg	A
	Promethazine Tab, 25mg		A
	Albendazole Tab, 200mg	Albendazole Tab, 200mg	A
		Folic Acid Tab, 5mg	A
		Iron Inj, 5ml	A
		Iron Inj, 2ml	A
		Ferrous fumarate Susp, 46mg/5ml	NA
		Iron Mixture (Infant) Syrup, 300mg/5ml	A
		Frusemide Inj, 20mg/2ml	A
Anaemia in pregnancy	Ferrous sulphate Tab, 200mg		NA
	Folic Acid Tab, 5mg		A
	Ferrous sulphate-folic Acid Tab, 200mg/25mcg		A
	Chloroquine Tab, 150mg		A
	Merbendazole Tab, 100mg		NA
	Albendazole Tab, 200mg		A
	Sulphadoxine-pyrimethamine Tab, 500mg/25mg		A
	Artemether Inj, 80mg/ml		A
	Frusemide Inj, 20mg/2ml		A
	Iron Inj, 5ml		A
	Promethazine Inj,		A

MDC=Medical and Dental Catalogue (A=Available, NA=Not Available)

Table 6.1.2b shows the different treatments for anaemia episodes listed in the STGs for both adults and children. The iron dextran injections (Table 6.1.2a) of 5ml and 2ml, and iron mixture (infant) syrup are listed in the catalogue. The treatment in the STGs only mentioned iron by oral administration in the form of fefol tablets and iron by injection.

Table 6.1.3a Drugs for treatment of asthma in PNG

STG	Dosage form	Strength	MDC	Dosage form	Strength	Cat	HCOF
Aminophylline	Inj	250mg/10ml	Aminophylline	Inj	250mg/10ml	A	A
Aminophylline	Tab	100mg	Aminophylline	Tab	100mg	A	NA
Salbutamol (Aerosol)	Spray	100mg	Salbutamol (Aerosol)	Spray	100mg	A	NA
Salbutamol	Inj	0.5mg/ml	Salbutamol	Inj	0.5mg/ml	C	NA
Salbutamol	Tab	4mg	Salbutamol	Tab	4mg	A	A
Salbutamol	Nebules	2.5mg/2.5ml	Salbutamol	Nebules	2.5mg/2.5ml	A	NA
Prednisolone	Tab	5mg	Prednisolone	Tab	5mg	B	NA
Salbutamol, 30ml	Soln	5mg/ml	Salbutamol, 30ml	Soln	5mg/ml	B	NA
Hydrocortisone acetate saline	Inj	25mg/ml	Hydrocortisone acetate saline	Inj	25mg/ml	B	NA
Penicillin benzyl	Inj	600mg	Penicillin benzyl	Inj	600mg	A	A
Amoxycillin	Tab	250mg	Amoxycillin	Tab	250mg	A	A
Amoxycillin	Cap	500mg	Amoxycillin	Cap	500mg	A	A
Doxycycline	Tab	100mg	Doxycycline	Tab	100mg	A	A
Adrenaline	Inj	1:1000/ml	Adrenaline	Inj	1:1000/ml	A	NA
Hydrocortisone sodium succinate	Inj	100mg	Hydrocortisone sodium succinate	Inj	100mg	A	NA
			Aminophylline	Elixir	25mg/5ml	A	A
			Aminophylline	Supp	400mg	A	NA
			Beclomethasone Dipropionate	Spray	100mcg	B	NA
			Ephedrine	Inj	30mg/ml	C	NA

STG=Standard treatment guidelines. MDC=Medical & Dental Catalogue. HCOF=Health Centre Order Form (A=Available, NA=Not available). Cat=Prescribers drug prescribing categories (A=All health workers, B=Medical Officers only, C=Specialist Medical Officers only as listed in MDC)

Table 6.1.3a shows the drug treatment for asthma listed in the PNG STGs, MDC and HCOF including the prescribing legislation categories.

Table 6.1.3b Asthma drug treatment for both adults and children as listed in the STGs

Asthma	Adults' Drugs	Children's Drugs	MDC
Mild attack	Salbutamol Nebules, 2.5mg/2.5ml	Salbutamol Nebules, 2.5mg/2.5ml	A
	Salbutamol Inj, 0.5mg/ml		A
	Salbutamol (Aerosol) Spray, 100mg	Salbutamol (Aerosol) Spray, 100mg	A
	Salbutamol Tab, 4mg	Salbutamol Tab, 4mg	A
	Amoxycillin Tab, 250mg		A
	Amoxycillin Cap, 500mg		A
	Doxycycline Tab, 100mg		A
Severe attack	Salbutamol Nebules, 2.5mg/2.5ml	Salbutamol Nebules, 2.5mg/2.5ml	A
	Salbutamol (Aerosol) Spray, 100mg	Salbutamol (Aerosol) Spray, 100mg	A
	Adrenaline Inj, 1:1000/ml		A
	Aminophylline Inj, 250mg/10ml	Aminophylline Inj, 250mg/10ml	A
	Hydrocortisone acetate saline Inj, 25mg/ml	Hydrocortisone acetate saline Inj, 25mg/ml	A
	Prednisolone Tab, 5mg	Prednisolone Tab, 5mg	A
	Aminophylline Tab, 100mg		A
	Salbutamol Tab, 4mg	Salbutamol Tab, 4mg	A
		Penicillin benzyl Inj, 600mg	A
		Amoxycillin Tab, 250mg	A
Chronic asthma	Salbutamol Tab, 4mg		A
	Aminophylline Tab, 100mg		A
	Salbutamol (Aerosol) Spray, 100mg		A

MDC=Medical & Dental Catalogue (A=Available, NA=Not available).

Table 6.1.3b shows the different treatments for asthma episodes listed in the STGs for both adults and children.

Table 6.1.4a Drug treatment for Tuberculosis (TB)

STG	Dosage form	Strength	MDC	Dosage form	Strength	Cat	HCOF
Isoniazid	Tab	100mg	Isoniazid	Tab	100mg	A	A
Rifampicin	Cap	150mg	Rifampicin	Cap	150mg	A	A
Ethambutol	Tab	400mg	Ethambutol	Tab	400mg	A	A
Pyrazinamide	Tab	500mg	Pyrazinamide	Tab	500mg	A	A
Streptomycin	Inj	1g	Streptomycin	Inj	1g	A	NA
Pyridoxine	Tab	25mg	Pyridoxine	Tab	25mg	A	NA
Rifampicin	Susp	100mg/5ml	Rifampicin	Susp	100mg/5ml	A	NA
			Cycloserine	Tab	250mg	C	NA
			Ethionamide	Tab	250mg	A	NA

STG=Standard treatment guidelines. MDC=Medical & Dental Catalogue. HCOF=Health Centre Order Form (A=Available, NA=Not available). Cat=Prescribers drug prescribing categories (A=All health workers, B=Medical Officers only, C=Specialist Medical Officers only as listed in MDC)

Table 6.1.4a shows the drug treatment for TB listed in the PNG STGs, MDC and HCOF including the prescribing legislation categories.

Table 6.1.4b Drug treatment for TB for both adults and children as listed in the STGs

TB	Adults' Drugs	Children's Drugs	MDC
	Isoniazid Tab, 100mg	Isoniazid Tab, 100mg	A
	Rifampicin Cap, 150mg	Rifampicin Cap, 150mg	A
	Ethambutol Tab, 400mg	Ethambutol Tab, 400mg	A
	Pyrazinamide Tab, 500mg	Pyrazinamide Tab, 500mg	A
	Streptomycin Inj, 1g	Streptomycin Inj, 1g	A
	Pyridoxine Tab, 25mg		A
		Rifampicin Susp, 100mg/5ml	A

TB=Tuberculosis. MDC=Medical & Dental Catalogue (A=Available, NA=Not available).

Table 6.1.4b shows the drug treatment for TB listed in the STGs for both adults and children.

Table 6.1.5a Drug treatment for arthritis

STG	Dosage form	Strength	MDC	Dosage form	Strength	Cat	HCOF
Aspirin	Tab	300mg	Aspirin	Tab	300mg	A	A
Paracetamol	Tab	500mg	Paracetamol	Tab	500mg	A	A
Indomethacin	Tab/Cap	25mg	Indomethacin	Tab/Cap	25mg	B	NA
Chloramphenicol	Cap	250mg	Chloramphenicol	Cap	250mg	A	A
Chloramphenicol paed, 100ml	Susp	125mg/5 ml	Chloramphenicol paed, 100ml	Susp	125mg/5ml	A	A
Doxycycline	Tab	100mg	Doxycycline	Tab	100mg	A	A
Amoxycillin	Cap	500mg	Amoxycillin	Cap	500mg	A	A
			Paracetamol	Supp	125mg	B	NA
			Paracetamol	Supp	250mg	B	NA
			Colchicine (gout)	Tab	0.5mg	B	NA
			Allopurinol (gout)	Tab	100mg	C	NA
			Indomethacin	Supp		A	NA
			Prednisolone	Tab	5mg	B	NA
			Methotrexate	Inj	50mg	D	NA
			Methotrexate	Tab	2.5mg	D	NA
			Methotrexate	Tab	10mg	D	NA

STG=Standard treatment guidelines. MDC=Medical & Dental Catalogue. HCOF=Health Centre Order Form (A=Available, NA=Not available). Cat=Prescribers drug prescribing categories (A=All health workers, B=Medical Officers only, C=Specialist Medical Officers only, D=Restricted to special indications only as listed in MDC)

Table 6.1.5a shows the drug treatment for arthritis listed in the PNG STGs, MDC and HCOF including the prescribing legislation categories.

Table 6.1.5b Drug treatment for arthritis for adults as listed in the STGs

Arthritis	Adults' Drugs	MDC
	Aspirin Tab, 300mg	A
	Paracetamol Tab, 500mg	A
	Indomethacin Tab/Cap, 25mg	A
Acute	Chloramphenicol Cap, 250mg	A
	Paracetamol Tab, 500mg	A
	Doxycycline Tab, 100mg	A
Chronic	Amoxycillin Cap, 500mg	A
	Amoxycillin Cap, 500mg	A
	Probenecid Tab, 500mg	A
	Amoxycillin-clavulanic Acid Tab, 500mg/125mg	A
	Azithromycin Tab, 500mg	A
	Erythromycin Tab, 250mg	A
	Co-trimoxazole Tab, 80mg/400mg	A
	Probenecid Tab, 500mg	A
Reactive	Doxycycline Tab, 100mg	A

MDC=Medical & Dental Catalogue (A=Available, NA=Not available).

Table 6.1.5b shows the different treatments for arthritis episodes listed in the STGs for adults. There is no arthritis treatment for children (Table 6.1.5b) listed in the standard treatment guidelines.

Table 6.1.6a Drug treatment for diabetes

STG	Dosage form	Strength	MDC	Dosage form	Strength	Cat	HCOF
Insulin	Inj					B	NA
			Insulin Human Regular	Inj	100u/ml	B	NA
			Insulin Human Isophane	Inj	100u/ml	B	NA
			Insulin Human Premix 70/30	Inj	100u/ml	B	NA
			Glibenclamide	Tab	5mg	C	NA
			Metformin	Tab	500mg	B	NA
			Vasopressin (diabetes insipidus)	Inj	20U/ml	D	NA

STG=Standard treatment guidelines. MDC=Medical & Dental Catalogue. HCOF=Health Centre Order Form (A=Available, NA=Not available). Cat=Prescribers drug prescribing categories (A=All health workers, B=Medical Officers only, C=Specialist Medical Officers only, D=Restricted to special indications only as listed in MDC)

Table 6.1.6a shows the drug treatment for diabetes listed in the PNG STGs, MDC and HCOF including the prescribing legislation categories.

Table 6.1.6b Diabetes drug treatment for adults as listed in the STGs

Diabetes	Adults' Drugs	MDC
Type I	Insulin Inj	A
Type II		
In pregnancy	Insulin Human Isophane Inj, 100u/ml	A
	Atrapid insulin	NA

MDC=Medical & Dental Catalogue (A=Available, NA=Not available).

Table 6.1.6b shows the different treatments for diabetes episodes listed in the STGs for adults. There is no treatment of diabetes for children listed in the STGs.

Table 6.1.7a Drug treatment for high blood pressure

STG	Dosage form	Strength	MDC	Dosage form	Strength	Cat	HCOF
Methyldopa	Tab	250mg	Methyldopa	Tab	250mg	B	NA
			Atenolol	Inj	5mg/10ml	C	NA
			Atenolol	Tab	50mg	B	NA
			Bendrofluazide	Tab	2.5mg	A	NA
			Diazoxide	Inj	15mg/ml	C	NA
			Enalapril	Tab	5mg	C	NA
			Frusemide	Tab	40mg	A	NA
			Frusemide	Inj	20mg/2ml	A	NA
			Propranolol	Tab	40mg	B	NA
			Propranolol	Inj	1mg/ml	B	NA
			Hydralazine HCl	Inj	20mg/ml	C	NA
			Hydralazine HCl	Tab	25mg	C	NA
			Methyldopa	Tab	250mg	B	NA
			Nifedipine	Cap	10mg	C	NA
			Nifedipine (S.R.)	Tab	20mg/ml	C	NA

STG=Standard treatment guidelines. MDC=Medical & Dental Catalogue. HCOF=Health Centre Order Form (A=Available, NA=Not available). Cat=Prescribers drug prescribing categories (A=All health workers, B=Medical Officers only, C=Specialist Medical Officers only as listed in MDC)

Table 6.1.7a shows the drug treatment for high blood pressure listed in the PNG STGs, MDC and HCOF including the prescribing legislation categories.

Table 6.1.7b Drug treatment for high blood pressure (HBP) **for adults as listed in the STGs**

Disease	Adults' Drugs	MDC
HBP	Methyldopa Tab, 250mg	A

HBP=High blood pressure. MDC=Medical & Dental Catalogue (A=Available, NA=Not available).

Table 6.1.7b shows the drug treatment for high blood pressure listed in the STGs for adults.

Table 6.1.8a Drug treatment for psychosis

STG	Dosage form	Strength	MDC	Dosage form	Strength	Cat	HCOF
Chlorpromazine	Inj	50mg/2ml	Chlorpromazine	Inj	50mg/2ml	A	A
Chlorpromazine	Tab	100mg	Chlorpromazine	Tab	100mg	A	NA
Diazepam	Tab	5mg	Diazepam	Tab	5mg	C	NA
			Diazepam	Inj	10mg/2ml	A	A
Promethazine, 2.5%, 2ml	Inj	25mg/ml	Promethazine, 2.5%, 2ml	Inj	25mg/ml	A	A
Promethazine	Tab	25mg	Promethazine	Tab	25mg	A	A
Benzhexol	Tab	5mg	Benzhexol	Tab	5mg	C	NA
			Fluphenazine Decanoate	Inj	25mg/ml	D	NA
			Haloperidol Decanoate	Inj	50mg/ml	D	NA
			Haloperidol Decanoate	Inj	5mg/ml	C	NA
			Haloperidol	Tab	5mg	C	NA
			Olanzapine	Tab	10mg	D	NA
			Trifluoperazine	Tab	5mg	C	NA
			Chlorpromazine	Syrup	25mg/5ml	B	NA
			Chlorpromazine	Tab	25mg	A	A
			Thioridazine	Tab	50mg	C	NA
			Amitriptyline	Tab	25mg	B	NA
			Fluoxetine	Tab	20mg	D	NA
			Lorazepam	Inj	2mg/ml	D	NA
			Lorazepam	Tab	1mg	D	NA

STG=Standard treatment guidelines. MDC=Medical & Dental Catalogue. HCOF=Health Centre Order Form (A=Available, NA=Not available). Cat=Prescribers drug prescribing categories (A=All health workers, B=Medical Officers only, C=Specialist Medical Officers only, D=Restricted to special indications only as listed in MDC)

Table 6.1.8a shows the drug treatment for psychosis listed in the PNG STGs, MDC and HCOF including the prescribing legislation categories.

Table 6.1.8b Drug treatment for psychosis for adults as listed in the STGs

Disease	Adults' Drugs	MDC
Psychosis	Chlorpromazine Inj, 50mg/2ml	A
	Chlorpromazine Tab, 100mg	A
	Diazepam Tab, 5mg	A
	Promethazine, 2.5%, 2ml Inj, 25mg/ml	A
	Promethazine Tab, 25mg	A
	Benzhexol Tab, 5mg	A

MDC=Medical & Dental Catalogue (A=Available, NA=Not available).

Table 6.1.8b shows the drug treatment for psychosis listed in the STGs for adults. There are no drug treatments listed for children.

Table 6.1.9a Drug treatment for urinary tract infection (UTI)

STG	Dosage form	Strength	MDC	Dosage form	Strength	Cat	HCOF
Amoxycillin	Cap	500mg	Amoxycillin	Cap	500mg	A	A
Amoxycillin	Tab	250mg	Amoxycillin	Tab	250mg	A	A
Amoxycillin	Susp	125mg/5ml	Amoxycillin	Susp	125mg/5ml	A	A
Probenecid	Tab	500mg	Probenecid	Tab	500mg	A	A
Amoxycillin-clavulanic Acid	Tab	500mg/125mg	Amoxycillin-clavulanic Acid	Tab	500mg/125mg	A	NA
Azithromycin	Tab	500mg	Azithromycin	Tab	500mg	B	NA
Erythromycin,	Tab	250mg	Erythromycin,	Tab	250mg	B	NA
Co-trimoxazole	Tab	80mg/400mg	Co-trimoxazole	Tab	80mg/400mg	A	A
Co-trimoxazole	Susp	40mg/5ml	Co-trimoxazole	Susp	40mg/5ml	A	A
Doxycycline	Tab	100mg	Doxycycline	Tab	100mg	A	A
Nitrofurantoin	Tab	100mg	Nitrofurantoin	Tab	100mg	C	NA
Nitrofurantoin	Susp	25mg/5ml	Nitrofurantoin	Susp	25mg/5ml	C	NA

STG=Standard treatment guidelines. MDC=Medical & Dental Catalogue. HCOF=Health Centre Order Form (A=Available, NA=Not available). Cat=Prescribers drug prescribing categories (A=All health workers, B=Medical Officers only, C=Specialist Medical Officers only as listed in MDC)

Table 6.1.9a showed the drug treatment for UTI listed in the PNG STGs, MDC and HCOF including the prescribing legislation categories.

Table 6.1.9b Drug treatment for urinary tract infection (UTI) for both adults and children as listed in the STGs

UTI	Adults' Drugs	Children's Drugs	MDC
	Amoxycillin Cap, 500mg		A
		Amoxycillin Tab, 250mg	A
		Amoxycillin Susp, 125mg/5ml	A
	Probenecid Tab, 500mg		A
	Amoxycillin-clavulanic Acid Tab, 500mg/125mg		A
	Azithromycin Tab, 500mg		A
	Erythromycin Tab, 250mg		A
	Co-trimoxazole Tab, 80mg/400mg	Co-trimoxazole Tab, 80mg/400mg	A
		Co-trimoxazole Susp, 40mg/5ml	A
	Doxycycline Tab, 100mg		A
		Nitrofurantoin Susp, 25mg/5ml	A

UTI=Urinary Tract Infection. MDC=Medical & Dental Catalogue (A=Available, NA=Not available).

Table 6.1.9b shows the drug treatment for UTI listed in the STGs for both adults and children.

Table 6.1.10a Drug treatment for Pneumonia

STG	Dosage form	Strength	MDC	Dosage form	Strength	Cat	HCOF
Amoxycillin	Cap	500mg	Amoxycillin	Cap	500mg	A	A
Amoxycillin	Tab	250mg	Amoxycillin	Tab	250mg	A	A
Amoxycillin	Susp	125mg/5ml	Amoxycillin	Susp	125mg/5ml	A	A
Chloroquine	Tab	150mg	Chloroquine	Tab	150mg	A	A
Sulphadoxine-pyrimethamine	Tab	500mg/25mg	Sulphadoxine-pyrimethamine	Tab	500mg/25mg	A	A
Amodiaquine	Tab	100mg	Amodiaquine	Tab	100mg	A	A
Promethazine	Tab	25mg	Promethazine	Tab	25mg	A	A
Aspirin	Tab	300mg	Aspirin	Tab	300mg	A	A
Paracetamol	Tab	500mg	Paracetamol	Tab	500mg	A	A
Penicillin benzyl	Inj	600mg	Penicillin benzyl	Inj	600mg	A	A
Chloramphenicol	Inj	1 gram	Chloramphenicol	Inj	1 gram	A	A
Chloramphenicol	Cap	250mg	Chloramphenicol	Cap	250mg	A	A
Gentamycin	Inj	80mg/2ml	Gentamycin	Inj	80mg/2ml	B	NA
Gentamycin	Inj	20mg/2ml	Gentamycin	Inj	20mg/2ml	B	NA
Salbutamol	Nebules	2.5mg/2.5ml	Salbutamol	Nebules	2.5mg/2.5ml	A	NA
Salbutamol, complete	Spray		Salbutamol, complete	Spray		A	NA
Digoxin, paed, 100ml	Elixir	50mcg/ml	Digoxin, paed, 100ml	Elixir	50mcg/ml	A	NA
			Azithromycin	Tab	500mg	B	NA
			Co-trimoxazole	Tab	80mg/400mg	A	A
			Co-trimoxazole	Susp	40mg/5ml	A	A
			Metronidazole	Tab	200mg	A	A
			Metronidazole	Inj	500mg/100ml	C	NA

STG=Standard treatment guidelines. MDC=Medical & Dental Catalogue. HCOF=Health Centre Order Form (A=Available, NA=Not available). Cat=Prescribers drug prescribing categories (A=All health workers, B=Medical Officers only, C=Specialist Medical Officers only as listed in MDC)

Table 6.1.10a shows the drug treatment for pneumonia listed in the PNG STGs, MDC and HCOF including the prescribing legislation categories. Azithromycin tablets (category B item) and metronidazole injections (category C item) are not available in the STGs and HCOF. Co-trimoxazole tablets (category A item) and suspension (category A item) and metronidazole tablets (category A item) are listed in the HCOF but not in the STGs.

Table 6.1.10b Drug treatment for Pneumonia for adults and children as listed in the STGs

PNA	Adults' Drugs	Children's Drugs	MDC
Mild	Amoxycillin Cap, 500mg		A
	Amoxycillin Tab, 250mg	Amoxycillin Tab, 250mg	A
	Chloroquine Tab, 150mg	Chloroquine Tab, 150mg	A
	Sulphadoxine-pyrimethamine Tab, 500mg/25mg	Sulphadoxine-pyrimethamine Tab, 500mg/25mg	A
		Amodiaquine Tab, 100mg	A
	Promethazine Tab, 25mg		A
	Aspirin Tab, 300mg		A
	Paracetamol Tab, 500mg		A
Moderate	Penicillin benzyl Inj, 600mg	Penicillin benzyl Inj, 600mg	A
	Amoxycillin Cap, 500mg		A
	Amoxycillin Tab, 250mg	Amoxycillin Tab, 250mg	A
	Aspirin Tab, 300mg		A
	Paracetamol Tab, 500mg		A
		Amodiaquine Tab, 100mg	A
	Chloroquine Tab, 150mg	Chloroquine Tab, 150mg	A
	Sulphadoxine-pyrimethamine Tab, 500mg/25mg	Sulphadoxine-pyrimethamine Tab, 500mg/25mg	A
		Quinine Tab, 300mg	A
		Quinine Inj, 120mg	A
		Artemether Inj, 40mg	A
		Artesunate Tab, 50mg	A
	Promethazine Tab, 25mg		A
Severe	Chloramphenicol Inj, 1 gram	Chloramphenicol Inj, 1 gram	A
	Chloramphenicol Cap, 250mg	Chloramphenicol Cap, 250mg	A
		Chloramphenicol Paed Oral Susp, 125mg/5ml, 100ml	A
		Penicillin benzyl Inj, 600mg	A
	Aspirin Tab, 300mg		A
	Paracetamol Tab, 500mg		A
	Artemether Inj, 80mg/ml		A
	Artesunate Tab, 50mg		A
	Sulphadoxine-pyrimethamine Tab, 500mg/25mg	Sulphadoxine-pyrimethamine Tab, 500mg/25mg	A
	Quinine dihydrochloride Inj, 600mg/10ml		A
	Quinine Tab, 300mg		A
	Gentamycin Inj, 80mg/2ml		A
		Amodiaquine Tab, 100mg	A
		Chloroquine Tab, 150mg	A
	Salbutamol Nebules, 2.5mg/2.5ml		A
		Digoxin, paed, 100ml Elixir, 50mcg/ml	A
		Salbutamol, complete Spray	A
		Salbutamol Nebules, 2.5mg/2.5ml	A

PNA=Pneumonia. MDC=Medical and Dental Catalogue (A=Available, NA=Not Available).

Table 6.1.10b shows the different treatments for pneumonia episodes listed in the STGs for both adults and children.

6.2 Discussion

Access to affordable, available, and assured quality of essential medicines is a vital component of an efficient health care system. In the resource-constrained environment of PNG with a high burden of disease, the value of the Standard Treatment Guidelines (STGs) and MDC (Essential Medicines List) [66] in facilitating affordable, available medicines of assured quality and equitable access to essential medicines should not be underestimated. STGs should keep pace with changes in health care. A continuous review of health workers adherence to the STGs and MDC [66] is imperative to promote access to quality and essential health care for the PNG population. The health system is tiered in PNG with serious cases being referred to provincial, or a referral hospital where doctors are available. However, most patients are initially treated at health centres or aid-posts by non-medical staff. Approximately 87.5% of the population live in the rural areas [165, 166] and their access to hospitals is often difficult or impossible, making the district health centre the highest level of care accessible [167].

Strong evidence shows that clinical guidelines and lists of essential medicines when properly developed, introduced and supported will improve prescribing quality and lead to better health outcomes [8]. An expectation is that the EML (MDC) [66] reflects closely items included in the STGs. This reduces the likelihood of inappropriate prescribing although it is still possible to select a drug listed for one disease and use it for another not included in the STGs for that disease.

Since essential drug lists are often neither well-constructed nor popular with clinicians, the concept has arisen that guidelines should come first and then the essential drug list automatically becomes the list of drugs recommended in the guidelines [168]. This change of emphasis from the construction of the essential drug list to the writing of guidelines means that the primary focus becomes the conditions to be treated rather than the drugs needed to treat them. This leads to a subtle but important change in the role of clinicians in that they are primarily asked how common and/or important conditions should be treated (based on evidence) rather than which drugs are needed on the

essential drug list. The use of an essential medicines list is finely interwoven with standard treatment guidelines and from there with maintaining a reliable supply of medicines of adequate quality [103].

In this study, inconsistencies between the listing of essential medicines in the MDC and STGs are investigated.

6.2.1 Malaria drug treatment

The malaria STGs (Table 6.1.1a & b) includes treatment for uncomplicated malaria, cerebral malaria, severe malaria, treatment failure malaria and malaria prophylaxis. The MDC is in conformity with the STGs. However, a few deficiencies are outlined below.

Quinine 120mg/2ml injections, quinine 600mg/10ml injections and quinine 300mg tablets are category B items respectively (Table 6.1.1a) which are restricted to medical officer prescribing. However, they are listed in the Health Centre Order Form (HCOF) and were available at LHC; and were being prescribed by HEOs, NOs and CHWs.

According to the STGs, artemether/artesunate tablets and injections are for treatment failure malaria and severe malaria. Yet, they were being prescribed for the treatment of uncomplicated malaria. This was an inappropriate drug selection according to the STGs. In a few cases sulphadoxine-pyrimethamine was prescribed alone, where it should be given as a combination treatment with amodiaquine, chloroquine or artesunate/artemether. There was no problem with the STGs and MDC but the problem was with the prescribers (MOs) not adhered to the STGs when prescribing the antimalarial drugs.

There are no medical officers working at health centres in PNG. Hence items restricted to medical officer prescribing but available to health centres via their standard order form, leads automatically to inappropriate prescribing with respect to prescriber category. This study was undertaken in 2010, after a new malaria treatment protocol was approved in 2009. However the implementation of the new protocol was delayed due to the non-availability of the new antimalarial drugs. Hence, the assessment of the antimalarial drugs for this study was based on the standard treatment guidelines in

place at the time of the survey. More research is needed to assess if the new protocol is being implemented and the STG guidelines are being followed. However, if the deficiencies in ensuring compliance of STGs with supply as demonstrated with this study have not been corrected, then inappropriate prescribing will be continuing. This should have included withdrawal of drugs no longer listed in the revised STGs.

The study by Pulford et al [169] on malaria case management in PNG prior to the introduction of the revised treatment protocol found that overall, 15% of observed fever patients (n = 468) were tested for malaria infection by a rapid diagnostic test and a further 3.6% were tested via microscopy. An anti-malarial prescription was given in 96.4% (451/468) of cases, including 100% (17/17) of test positive cases and 82% (41/50) of test negative cases. In all, 79.8% of anti-malarial prescriptions conformed to the treatment protocol current at the time of data collection. The purpose of the prescribed medication was explained to patients in 63.4% of cases, dosage/regimen instructions were provided in 75.7% of cases and the possibility of adverse effects and how they manifest were discussed in only 1.1% of cases. Of the 201 patients provided a recommended anti-malarial prescription in take away form, the correct dosage for the respective regimen was provided in 75.6% (152/201) of cases, an incorrect dosage was provided in 15.9% (32/201) of cases, and in 8.5% (17/201) of cases a determination as to the correctness (or otherwise) of the provided medication dosage could not be made. They concluded that the revised national malaria treatment protocol will require a substantial change in current clinical practice if it is to be correctly implemented and adhered to. Areas that will require the most change include the shift from presumptive to RDT/microscopy confirmed diagnosis, prescribing (or rather non-prescribing) of antimalarials to patients who test negative for malaria infection, and the provision of thorough treatment counselling. A comprehensive clinician support programme, possibly inclusive of 'booster' training opportunities and regular clinical supervision will be needed to support the change. For example, a suitable program could be developed based on the methods used by the Australian Prescribing Service [170].

6.2.2 Drug treatment for anaemia

Folic Acid 5mg tablet and Iron Dextran 5ml injection are category A items (Table 6.1.2a) but were not listed in the HCOF. Ferrous fumarate suspension is listed in the STG but

not listed in the MDC and HCOF. Iron infant mixture (category A item) is listed in the STG and MDC but not in the HCOF. Folic Acid injection and hydroxycobalamine injection (category C items) are listed in the MDC but not in the STGs. This indicate that the MDC was not aligned with the STGs and prescribing these drugs at the health centre would always be inappropriate.

6.2.3 Drug treatment for asthma

It is notable that the current STGs approach is only symptom relief rather than long-term management of the disease. The STGs are silent regarding patients requiring continuing salbutamol treatment. Beclomethasone spray is not listed in the STG but is however listed in the MDC and its prescribing is restricted to Medical Officers.

Aminophylline 25mg/5ml elixir (Table 6.1.3a) is a Category A item and listed in the MDC and HCOF but not in the STGs. Aminophylline suppository (category A item), beclomethasone dipropionate spray (category B item) and ephedrine injection (category C item) are listed in the MDC but not in the STGs and HCOF.

Asthma management is based on the concept of controlling symptoms with “reliever” medication and long term prevention of symptoms with “preventers” (eTG). The most commonly recommended “reliever” treatment is the short-acting β_2 agonist salbutamol as an inhalation. Inhaled corticosteroids are first-line maintenance “preventer” treatment with inhaled beclomethasone a commonly suggested option (eTG). Exercise induced asthma is managed with short-acting β_2 agonists (eTG).

In the management of a mild attack in adults nebulised salbutamol is the first-line treatment in the PNG STGs. Salbutamol using a spacer or tablets are other options. The STGs additionally state to treat infection with amoxicillin or doxycycline. Although asthma can be precipitated by an infection, it is not the only trigger and many of those infections will be viral in origin. In children, salbutamol puffer using a spacer device could be used, or if not available, then the STGs suggest using salbutamol tablets. Surprisingly, the nebuliser delivery option is not recommended for children. The availability of working nebuliser machines is unknown across the health facilities of PNG.

6.2.4 Drug treatment for tuberculosis

The MDC is in conformity with the STGs.

6.2.5 Drug treatment for arthritis

There are several categories listed under this heading in the STGs including acute arthritis, septic arthritis, tropical or reactive arthritis, trauma, gout and rheumatic fever. Chronic arthritis includes osteoarthritis, gout, tuberculosis arthritis and rheumatoid arthritis. The drugs listed in Table 6.1.5a are suitable to manage an acute onset case. It is notable that the STGs do not include treatments for gout however colchicine and allopurinol are included in the MDC. Prescribing for these is restricted to Medical Officers or specialists. Prednisolone can also be included in the same category (category B item).

For the treatment of rheumatoid arthritis, only paracetamol and exercise are included as options in the PNG STGs. The eTG (Australia) suggests methotrexate or prednisolone for rheumatoid arthritis. Both of these drugs are listed in the MDC restricted to medical prescribers only.

6.2.6 Drug treatment for diabetes

Insulin injections (Table 6.1.6a) are prescriber category B items and were not available at LHC. The STGs for adults in PNG only mentioned insulin injections as a drug treatment option. There are three types of insulin injections; Insulin Human Regular, Insulin Human Isophane, and Insulin Human Premix 70/30 listed in the MDC. These are not mentioned in the PNG STGs. Atrapid insulin is listed in the STGs but not in the MDC. Diabetes Type 2 pharmacological treatments were not included in the STGs.

Diabetes drug treatment is only listed in the adult STG and there is no mention of diabetes drug treatment (Table 6.1.6b) for children in the children STG. The disease is subdivided into Types 1 and 2. The STGs drug treatment for Type 1 is insulin injections and Type 2 by lifestyle modifications. A range of insulin products are listed in the MDC. The eTG (Australia) lists metformin as the drug of first choice in Type 2 diabetes.

Sulfonylureas such as gliclazide, glipizide, gliblenclamide, and glimepiride are also listed in the eTG. The eTG cautions the use of glibenclamide because of its adverse effect profile and the possibility in older people causing severe prolonged hypoglycaemia. It is notable that metformin and glibenclamide are both listed in the MDC with the former restricted to medical prescribers and the latter medical specialists. Hence it would seem some of the caution regarding glibenclamide has been incorporated into the MDC by restricting it to specialists. The fact of their inclusion in the MDC but not in the adult STG is baffling.

6.2.7 Drug treatment for high blood pressure

Methyldopa 250mg tablet (Table 6.1.7a) is a category B item and was not available at LHC. Bendrofluazide 2.5mg tablet is the only category A item but is not listed in the STGs and not available at the LHC, also it is not listed in the HCOF.

Hypertension is listed as “high blood pressure” in the PNG STGs and management is limited to lifestyle changes, salt reduction and methyldopa. It is suggested the patient is referred to a medical officer if the patient meets specific criteria. No guidance is provided to medical officers on additional management options.

The MDC [66] however lists drugs that encompass several classes of antihypertensive drugs including ACE inhibitors, calcium channel blockers, diuretics, beta blockers, direct acting vasodilators and centrally acting antiadrenergic drugs. The only option included in the STGs is methyldopa which is a centrally acting antiadrenergic drug. According to the eTG (Australia) [171], methyldopa would be mainly used for hypertension associated with pregnancy. The eTG [171] suggests that commencement treatment would be with an ACE inhibitor, calcium channel blocker or thiazide or thiazide-like diuretics. With the exceptions of bendrofluazide and frusemide listed in the MDC [66] all other options are limited to prescribing by medical officers or medical specialists. No antihypertensive agent (including category A items) is included on the HCOF. The STGs provide no guidelines to Medical Officers on the management of hypertension yet provide an adequate range of treatment options in the MDC [66]. Careful revision of the STGs is essential.

6.2.8 Drug treatment for psychosis

Chlorpromazine 100mg tablets are listed (Table 6.1.8a) in both the STGs and MDC [66] but not in the HCOF and not available at LHC. However, chlorpromazine 25mg tablet is listed in the HCOF but not STGs but is available at LHC. Diazepam injection may be included for muscle relaxation for a minor procedure, rather than for psychotic conditions.

The PNG STGs focus on the initial management of violent or aggressive behaviour or mental disturbance. Initial management in the STGs is with parenteral chlorpromazine, with additional use of oral diazepam if necessary. Potential side effects of chlorpromazine are managed with promethazine or benzhexol. Patients can be stabilised on oral chlorpromazine and monitored. If adequate control is not achieved then the patient should be transferred.

The STGs suggests where possible parenteral management of patients is avoided unless they pose a risk to themselves or others. The eTG (Australia) [171] suggests parenteral haloperidol which is included in the MDC but not listed in the STGs.

The MDC includes a range of antipsychotic and antidepressant drugs not included in the STGs. These include fluphenazine and haloperidol injectable products and haloperidol tablets. In addition the atypical antipsychotic olanzapine as tablets is included. In addition, the other phenothiazines, trifluoperazine and thioridazine are additional MDC listings.

Although depression is not a condition listed in the STGs the tricyclic amitriptyline and the selective serotonin reuptake inhibitor (SSRI) fluoxetine are included in the MDC. In addition to diazepam a shorter acting benzodiazepine lorazepam is also included in the MDC but any basis for its inclusion is unclear.

With the exception of chlorpromazine, diazepam and promethazine injections and chlorpromazine and promethazine tablets all other CNS medications are restricted to medical officers, specialists or restricted to special indications.

6.2.9 Drug treatment for urinary tract infection (UTI)

The MDC is in conformity with the STGs.

6.2.10 Drug treatment for Pneumonia

Drug treatment for pneumonia (Table 6.1.10a & b) includes treatments for mild, moderate and severe pneumonia. Co-trimoxazole 80mg/400mg tablets and 40mg/5ml suspension (Category A items) are not listed in the STGs but are listed in the MDC and HCOF.

6.2.11 Role of Standard Treatment Guidelines in PNG

The STGs and MDC have played a leading role in the healthcare system in PNG for a number of years. However, despite them being available, the overall health indicators for PNG are not improving. According to the PNG National Health Plan 2011-2020 [98]; "The main health concern is poor maternal health. Maternal deaths have been increasing in the past ten years". The PNG Millennium Development Goals target for 2015 is to decrease maternal deaths to 274 per 100,000 live births, while it is now about 733. This would require significant changes to the current systems to achieve the required outcome. This data currently ranked PNG as the second highest in the world in maternal mortality, after Afghanistan and outside Sub-Saharan Africa [98]. Health of children similarly remains of concern. One child in every thirteen born in PNG will die before the age of five years, a rate far greater than in any other country of the Pacific region. Acute respiratory infections (in particular, pneumonia) take a high toll. They are the leading cause of hospitalization, and besides neonatal conditions, the leading cause of deaths in health facilities. Malaria remains an intractable problem in PNG, and is the second most common cause of admission to hospital. It affects all age groups, but is most lethal in children, and with serious consequences in pregnancy. Tuberculosis is again of increasing concern. With the exception of obstetric cases, tuberculosis now consumes 13% of hospital bed days, more than any other illness. Non-communicable diseases (for example, cardiovascular disease, diabetes, chronic respiratory illness and renal disease) occur, but the numbers are small to date. Furthermore, procurement and distribution of medical supplies and vaccines to health facilities in PNG remains a major challenge for the health sector. The evidence shows that there is a consistent low

availability of key essential medicines. In 2004, 40% of Health Centres were supplied by kits to supplement the routine supply chain. However, this has not improved the situation, with 'stock outs' of key essential medicines increasing in health facilities [98]. This situation indicates that the current system is failing all Papua New Guineans.

The National Drug Policy stated that PNG since 1950 has succeeded in developing, maintaining and financing a pharmaceutical supply system (EML), which provides continuous access to a limited range of essential drugs, of acceptable quality and at reasonable cost, tailored to each level of health care [63]. Clearly the current data indicates that although the structure is there, the system has failed [98].

Papua New Guinea was at the forefront of the development of standard treatment regimens. In 1974 a national workshop attended by all the paediatricians in the country, paediatric trainees and paediatric nurse tutors reached a consensus for a national manual of Paediatric Standard Treatment. The result was the 1st edition of the children's STG [172].

Studies in PNG by Samiak and Vince [172], and Vince and Mokela [173], indicated that health workers of different levels of training undoubtedly valued the STGs, but there was evidence that it is frequently not used appropriately. As seen in this study medical prescribers made about 27.7%-31% errors in inappropriate prescribing based on drug selections. This simply means that they did not adhere to the STGs.

6.2.12 Role of Standard Treatment Guidelines in developing countries

The STGs have made an impact in many developing countries and PNG is no exception as they summarise recommended treatments for commonly occurring conditions specific to each country. Generally, they should represent a consensus on what is regarded as the most appropriate treatment for each condition. The aim of providing such information is that treatments become standardised throughout a health system and that prescribing for the conditions covered is rationalised. Widespread adoption and application of standardised treatments also make it possible to use these, together with morbidity and patient attendance data, as a basis for quantification of drug requirements. STGs are useful to prescribers as ready reference texts for consultation

during the course of daily clinical work and also as resource materials for basic and in-service prescriber training [174].

Hogerzeil [8] documented that since the 1970s many developing countries have started national programmes for essential drugs to promote the availability, accessibility, affordability, quality, and rational use of medicines. The cornerstone of such programmes is the careful selection of essential medicines for public supply and reimbursement, based on a systematic review of comparative efficacy, safety, and value for money; evidence based national clinical guidelines as the basis for training and rational prescribing; and a national medicines policy to balance conflicting policy objectives and to express government commitment to a common goal.

Developing countries are faced with limited health budgets and irrational drug use and in line with the concept of essential medicines launched by WHO in 1977, most have gone ahead to develop their own STGs and EML of which PNG is no exception. Since then, about 135 countries had developed national clinical guidelines, mostly linked to national lists of essential medicines. Good examples are Zimbabwe, South Africa and, more recently, Delhi State Capital Territory [8].

6.2.13 Studies undertaken in PNG

One study has been undertaken in PNG evaluating the STGs in PNG. A study by Samiak and Vince [172] assessed the self-reported frequency and quality of use of the Paediatric STG by staff in urban clinics and rural health centres in PNG. Sixty one (61) of the eighty eight (88) nursing officers and forty four (44) of the eighty nine (89) community health workers in nine urban and four rural health settings completed written questionnaires on their use of the STG. The survey of participants also assessed the management of three case scenarios of common clinical conditions. Whilst 69% of the participants reported daily use of the book, only 51% indicated that they always followed the guidelines. Performance in the case scenarios was poor. Although 87% made a correct diagnosis in the most straightforward case, only 38% indicated complete treatment and only 36% indicated complete and correct advice. In two more complex scenarios less than 30% of the participants made a correct diagnosis and less

than 10% indicated complete treatment and advice. This finding may provide some limited insight to current healthcare management in PNG.

6.2.14 Issues of mismatch of STGs and MDC

It is very essential that the level of mismatches between the STGs and MDC as identified in this study are addressed by the appropriate PNG health authorities. It was discovered that there were notable inconsistencies in the following disease treatments; anaemia, asthma, TB, arthritis, diabetes, high blood pressure, psychosis, and pneumonia. In most of these cases, drugs listed in the MDC that were disease specific, were however not listed in the STGs. This was one of the main reasons giving rise to inappropriate prescribing reported earlier in this study. It is notable that at that time, the MDC preceded the STGs in publication date.

Since the completion of this study, revised STGs have been issued in 2012 for the management of diseases for adults [175] and children [176], a new MDC 10th Ed [177] and a new National Medicines Formulary [178]. Hence, their impact is yet to be seen but outlined below are a few selected changes made in the new STGs compared with the previous editions of the STGs. With respect to the specific deficiencies identified in this study, the revised 6th edition of the STG for adults [175] and 9th edition of the STG for children [176] contained the following changes:

6.2.14.1 Dose tables for children

This study has found many incorrect determinations of dosage for a specific weight when the dose per kg body weight is provided. The new revised STG 9th edition for children [176] contains the maintenance doses of all commonly used drugs listed in the STG for children from a month old. The doses are given by dose per kg body weight, and number of doses each day similar to the 8th edition [69]. The editors would have been unaware of the findings of this study regarding dosage calculation errors. Interventions such as providing dose for weight tables need to be developed and tested prior to a further edition of the STG being prepared.

6.2.14.2 Malaria drug treatments

Blood slides and/or Malaria Rapid Diagnostic Tests (RDTs) are now the cornerstone of malaria diagnosis and must be done before antimalarial drugs are prescribed. The STGs for malaria treatments have been radically amended to incorporate artemether-lumefantrine tablet and primaquine tablet as first line drug treatment for malaria. This may have some impact on reducing the level of medically based inappropriate drug prescribing of artemisinin products prior to the official change in the STGs. From enquiries, the previously available antimalarials were not withdrawn from health centres and hospitals.

6.2.14.3 Asthma

The asthma drug treatment for adults is as follows: For a mild attack: salbutamol inhaler, nebulised salbutamol solution, salbutamol tablet, amoxycillin capsule (for infections), doxycycline tablet, and Inhaled salbutamol via spacer. For severe attack: nebulised salbutamol solution, salbutamol inhaler, adrenaline injection, hydrocortisone IV injection, prednisolone tablet, magnesium sulphate IV injection, aminophylline IV injection, prednisolone injection, salbutamol tablet, and aminophylline tablet. For chronic asthma: beclomethasone dipropionate (becotide) 100µg via spacer and salbutamol inhaler. There is the notable addition of the inhaled corticosteroid replacing aminophylline.

The asthma drug treatment for children is: For mild asthma - salbutamol (ventolin) inhaler and salbutamol tablet. For severe asthma - nebulised salbutamol respirator solution, salbutamol (ventolin) tablet, prednisolone tablet, hydrocortisone Injection, aminophylline IV (250mg/10ml ampoule), benzylpenicillin (crystalline) injection, salbutamol by inhaler with spacer, and amoxicillin tablet/capsule. There has been no changes from the previous edition. There is no long-term treatment provided for asthma using “preventer” medication.

6.2.14.4 Arthritis

For acute arthritis: paracetamol tablets, indomethacin capsules, aspirin tablets, diclofenac tablets, flucloxacillin capsules, and ceftriaxone injection (IM/IV). For chronic arthritis: paracetamol tablets, doxycycline tablets, amoxicillin capsules, and allopurinol tablets. It is notable that diclofenac has been added for pain relief and allopurinol now included for gout.

6.2.14.5 Diabetes

Type 1 diabetes is rare in PNG and no drug treatment is listed and hence treatment guidelines have been removed. This seems a change difficult to justify. Type 2 diabetes is the most common in PNG and its' drug treatment is: metformin tablets, glibenclamide tablets, and insulin isophane injection. The complications are managed with enalapril tablets, captopril tablets, and simvastatin tablets. Type 2 diabetes drug treatments are additions and insulin has been removed for the treatment of Type 1 diabetes. These are all restricted to medical prescribers.

6.2.14.6 Hypertension

The drug treatment for high blood pressure is: bendrofluazide tablets, enalapril tablets, atenolol tablets, and methyldopa tablets. These are drug treatments introduced in this adults STG edition [175]. It is noteworthy that some small changes have occurred in the revised edition. These have selected drugs that were available in the existing MDC but not previously included in the adults STG. The changes made especially in hypertension would have decreased the level of inappropriate prescribing by medical prescribers.

6.2.14.7 Psychosis

The general drug treatment is: chlorpromazine IM injection, chlorpromazine tablets and diazepam tablets. The side effects of chlorpromazine is treated with;

promethazine IM injection, promethazine tablets and benzhexol tablets. This is unchanged.

6.2.14.8 Prescriber restrictions/categories

There are no changes in the general information on prescribers' categories except the category D item (restricted to special indications only) has been removed. In the 10th edition of MDC [177], category D items are now meant for Pharmacist and Pharmacy Technicians prescribing items only. With regard to prescribers' categories for individual drugs, the few changes noted in the MDC 10th edition [177] and the new revised STGs are as follows:

Asthma

Prednisolone injection is listed in STG [175] but not listed in the MDC [177]. Magnesium sulphate injection was a category B item but now categorised an A prescribing item.

Arthritis

Diclofenac tablet is a category B item. Ceftriaxone injection was a category C item but now categorised as a B item.

Diabetes

For Type 2 treatment, metformin tablet, glibenclamide tablet, insulin isophane injection, and enalapril tablets are new additions with no changes in their prescribing categories. Captopril tablet is listed in STG [175] but not listed in MDC [177] and simvastatin tablet is a category B item.

Hypertension

Bendrofluazide tablets was a category A item but is no longer listed in the MDC [177]. Enalapril tablets and atenolol tablets are unchanged in their prescribing categories.

Anaemia

Ferrous fumarate susp, 46mg/5ml, is listed in the children STG [176] but not listed in the MDC [177].

Pneumonia

Amoxicillin 125mg/5ml suspension is now listed in the children STG [176] with no change in prescribing category for severe pneumonia. For the adults; ceftriaxone injection was a category C item but now a category B while benzyl penicillin injection, salbutamol inhaler, doxycycline tablet, and erythromycin tablet are new additions with no overall changes in their prescribing categories.

UTI

For the adult; ciprofloxacin tablet is now listed in the adult STG (2012) and categorised a B prescribing item while cefaclor capsule and nitrofurantoin tablet are new additions with no changes in their prescribing categories.

Despite the introduction of the new revised editions of the STGs and MDC, the few deficiencies outline above strongly indicated that the MDC (2012) edition did not take note (worked in isolation) of the drugs listed in the STGs (2012). There have been some changes especially with hypertension and Type 2 diabetes that would decrease inappropriate prescribing, however many deficiencies have been carried forward. Therefore, inappropriate prescribing will continue based upon the continuing mismatch of the STGs and MDC, in addition to those occurring from prescribers not following the guidelines.

6.2.15 STGs and Prescribers

The STGs used for this study for both adults and children were titled as a manual for nurses, community health workers, health extension officers and doctors. It was notable that the different types of prescribers made different prescribing errors. For example, non-medical prescribers made more dosage calculation errors than medical prescribers who made mainly drug selection errors. In the former case, either specific dosage tables based on weight could be provided along with education to improve dosage calculations. In the latter case, the discontinuities between the MDC and STGs are

giving rise to the opportunity to make inappropriate drug selections. As shown in this study, the STGs management of some chronic diseases such as type 2 diabetes, hypertension, and mental health, the MDC lists drugs not included in the STGs, but are included in other guidelines such as the Australian eTG where these drugs are considered in many cases first line treatment for these diseases. This leads us to conclude that the current STGs have not been formulated to treat chronic diseases however these can be treated by medical doctors within the scope of the MDC but not the STGs. There may be a reluctance of the PNG authorities at this stage in making available these drugs to non-medical prescribers as most of those included in the MDC available for treatment of these diseases are restricted to medical prescribers only. Hence, the STGs used for this study provide no guidance to medical doctors on the selection of these drugs for the treatment of chronic diseases. It is notable that in the case of type 2 diabetes and hypertension, this has been partially addressed by the latest edition of the adults STG.

A study by Holloway et al. [179] in assessing the progress of improving the use of medicines in developing and transitional countries revealed that inappropriate medicine use remains a serious global problem. Despite the small increases over time, only 50% of treatment prescribed followed STGs at the end of the study period in 2009. The percentage of medicines prescribed by all prescribers that were included in an EML in the Western Pacific region of which PNG is a part of was at 75.5% and the percentage of patients treated according to STGs was 35%. The percentage of medicines prescribed from an EML by doctors alone was at 73.9% and the percentage patients treated according to STGs by doctors alone was only at 33.3%.

This study has also found approximately 67% of drug prescribing by all prescribers was in accordance with the STGs, however essentially all of the drug prescribing was within the scope of the MDC. In hospitals and health centres in PNG few drugs are available that are not included in the MDC. This is often not the case in developing countries so in PNG there is an opportunity to align the STGs and MDC to achieve a high level of appropriate prescribing.

6.2.16 Factors that may be limiting success of STGs

As pointed out by Holloway [29], clinical guidelines give recommendations in relation to appropriate treatment with the aim of improving the quality of care. Many guidelines have been developed in recent years for all cadres of health staff and health facilities, but their impact has not been well studied in terms of cost–effectiveness and long-term patient outcomes [180, 181]. Implementation of guidelines is a complex process [181-183] and appears to be enhanced by a higher quality of evidence supporting the recommendations, better compatibility of the recommendations with existing values, less complexity of required decision-making, better descriptions of desired behaviours, and fewer new skills and organizational changes needed to follow the recommendations [181].

Cabana et al [113] outlined factors that act as barriers that affect prescribers' adherence to STGs. These are: lack of awareness, lack of familiarity, lack of agreement, lack of self-efficacy, lack of outcome expectancy, inertia of previous practice, external barriers, guideline-related barriers, patient-related barriers, and environmental-related barriers. Hence, not all but some of these barriers would have contributed to prescribers' non-adherence to STGs in PNG. It should be noted that the level of prescriber on all of the above barriers is yet to be studied in PNG. In addition, it was found that the STGs were available at all centres where this study was undertaken.

As shown in this study, the medical prescribers made 31.3% errors (inappropriate drug prescribing) mainly in selecting drugs not listed in the STGs. The barriers assumed most likely affecting the prescribers' non-adherence to the STGs in PNG would be; lack of agreement, environmental related, guideline related, external barriers and inertia of previous practice.

On the other hand, the non-medical prescribers made from 12.2-19.5% errors (inappropriate drug prescribing) mainly in drug dosage. The barriers most likely affecting this would be; lack of familiarity, environmental related and external barriers.

Regarding these barriers, on the lack of agreement, Physicians may not agree with a specific guideline or the concept of guidelines in general. Although physicians

commonly indicate a lack of agreement when asked about guidelines in theory, from this analysis and others, when asked about specific guidelines, physician lack of agreement is less common. The results of studies that examine physician attitudes to guidelines in general should be interpreted with caution when applied to specific guidelines. A lack of familiarity or casual awareness does not guarantee familiarity of guideline recommendations and the ability to apply them correctly. Of 74 surveys that measured guideline awareness or familiarity, lack of familiarity was more common than lack of awareness. On the inertia of previous practice, Physicians may not be able to overcome the inertia of previous practice, or they may not have the motivation to change. Of all the 14 surveys that examined this barrier, more than 20% of respondents indicated that it was a barrier to adherence. With regard to the external barriers, appropriate knowledge and attitudes are necessary but not sufficient for adherence. A physician may still encounter barriers that limit his/ her ability to perform this recommended behaviour due to patient, guideline, or environmental factors. External barriers that limit the ability to perform a recommended behaviour are distinct from lack of self-efficacy. For example, well-trained physicians confident about their counselling skills can still be affected by external barriers (time limitations, lack of a reminder system) that prevent them from adhering to a counselling guideline. However, the persistence of these barriers may also eventually affect physicians' self-efficacy, outcome expectancy, or motivation.

On the guideline-related barriers, Physicians were more likely to describe guidelines as not easy to use or not convenient when asked about guidelines in theory. When physicians were asked about barriers for specific guidelines, a significant percentage (>10%) described them as inconvenient or difficult to use. Guidelines recommending elimination of an established behaviour may be more difficult to follow than guidelines that recommend adding a new behaviour. Regarding the environmental-related barriers, adherence to practice guidelines "may require changes not under physician control, such as acquisition of new resources or facilities." For example, unavailability of an anaesthetist 24 hours a day may interfere with physician ability to adhere to guidelines aimed at decreasing the rate of elective caesarean deliveries. Many factors described as barriers by more than 10% of respondents, such as lack of a reminder system, lack of counselling materials, insufficient staff or consultant support, poor reimbursement, increased practice costs, and increased liability, may also be factors beyond physician

control. With adequate resources or referral privileges, physicians may be able to compensate for other external barriers [113].

The barriers giving rise to poor compliance with STGs in PNG are yet to be investigated. It is strongly recommended that further studies need to be undertaken to evaluate the barriers affecting prescribers adherence to STGs in PNG.

In addition, Grimshaw et al. [183] suggested the following in terms of guideline implementation strategies: Reminders are potentially effective and are likely to result in moderate improvements in process of care; Educational outreach in combination with educational materials appears to have positive effects however it is a costly model to implement. This has been used by the National Prescribing Service in Australia [184]; Audit and feedback show modest effects; Educational materials added to other interventions do not seem to increase the effectiveness of those interventions; Multifaceted interventions do not appear to be more effective than single interventions and the effects of multifaceted interventions do not appear to increase with the number of interventions.

Other studies state that a combination of strategies to improve the implementation of guidelines is usually more effective than single strategies [182, 185]. However, in developing countries, multiple intervention packages often include building infrastructure, such as supervisory systems, which are likely to increase their impact [29].

6.2.17 Comparison with relevant literature

A study by Pillay et al. [186] made an assessment study of prescriber adherence to standard anti-hypertensive treatment guidelines in South Africa analysing records of the anti-hypertensive drugs supplied to all 54 public-sector hospitals with a hypertension clinic in KwaZulu-Natal and a direct-observation survey of anti-hypertensive drug prescriptions presented to pharmacies in a subset of 16 of the 54 hospitals. The supply data showed that, in line with treatment guidelines, diuretics and angiotensin-converting enzyme inhibitors were the most frequently supplied medicines (42% and 27%, respectively). However, methyldopa – not included in the treatment guidelines – represented 10% of all anti-hypertensives supplied, but the proportion varied widely

between hospitals (0–37%). Reserpine, second choice in the treatment guidelines, was used in high amounts by only two hospitals. Calcium channel blockers and beta blockers represented a small proportion of the anti-hypertensive drugs supplied of 6% each. Results from the prescription survey were in concordance with supply data for the most frequently prescribed drugs but gave slightly different estimates of the use of others. Their results showed substantial non-adherence to standard treatment guidelines which is something similar to PNG as seen in this study. This also highlights the variations that occur in prescribing dependent upon the location/centre when guidelines are not followed.

Higuchi et al. [187] conducted a study on the application of standard treatment guidelines in rural community health centres, Timor-Leste and found that the respondents (nurses) were willing to use STGs and believed that they 'should' follow them. This arose due to their self-awareness as frontline health workers and, at the same time, as peripheral civil servants. The changes brought about by the introduction of STGs were positively perceived. Three components of the change were observed: the concept, daily practice and perceived patient satisfaction. The respondents had previously felt a lack of confidence and hoped to improve their capacity as health care workers; they became confident in their practices by using STGs. Self-confidence was identified more clearly in the clinical nurse interviews. Few difficulties in using STGs were indicated, and the respondents suggested ways to deal with these difficulties.

Walter et al. [188] concluded in their study on why first-level health workers failed to follow guidelines for managing severe disease in children in the Coast Region, the United Republic of Tanzania. In total, 502 cases were reviewed at 62 facilities. Treatment with antimalarials and antibiotics was consistent with the diagnosis given by health workers. However, of 240 children classified as having "very severe febrile disease", none received all IMCI-recommended therapies, and only 25% of severely ill children were referred. Lethargy and anaemia diagnoses were independently associated with referral. Most (91%) health workers indicated that certain severe conditions can be managed without referral. The health workers surveyed rarely adhered to IMCI treatment and referral guidelines for children with severe illness. They administered therapy based on narrow diagnoses rather than IMCI classifications, disagreed with referral guidelines and often considered referral unnecessary. To improve implementation of IMCI,

attention should focus on the reasons for health worker non-adherence identifying the barriers as classified by Cabana et al. [113].

This study has shown that the STGs were not complied with, to an acceptable level by medical and non-medical prescribers in PNG. Inconsistency between the STGs and the MDC are a major factor in enabling this to occur. Although the revised STGs have gone some way to improving this issue, a much greater effort is essential to align the STGs with the MDC and address the inability to calculate dosages for children.

7.0 GENERAL DISCUSSION

This is the first study that has systematically evaluated the prevalence of inappropriate drug prescribing by medical and non-medical staff in different healthcare locations in PNG. A sample in excess of 1000 patients was evaluated over three locations ranging from a rural health centre, a provincial hospital and the main referral hospital in the country.

Research into the area of inappropriate drug use has been reported in the literature over the past forty plus years. The WHO Conference of Experts on the Rational Use of Drugs, held in Nairobi on 25-29 November 1985 was an important turning point which made way for the health authorities in its member countries to examine the incidence and possible consequences of irrational drug use [34]. Hence, this work has contributed to studies evaluating the utilization of drugs / rational drug use which includes appropriate prescribing [189].

Papua New Guinea predominately consists of rural communities (87.5% of the country's population is living in rural areas) making access to health care often difficult, slow and expensive [167]. Most of these communities are serviced by health centres and aid-posts and few (less than 12.5%) have access to public hospitals. Only 3% of the roads are paved and many villages can only be reached on foot. Most travel between provinces is by air. The capital, Port Moresby, is not linked by road to the remainder of the country. Access to the capital is by air or sea travel unless resident in the National Capital District.

Currently in PNG, there are 20 Government funded provincial hospitals including Port Moresby General Hospital, one specialist psychiatric hospital, 48 Urban Clinics, five District/rural hospitals, 307 health/sub health centres, and 2672 aid-posts [190].

The services to be provided by these hierarchical healthcare facilities are outlined in the PNG HSDP [190];

Provincial hospitals and Port Moresby General Hospital provide core clinical services and subspecialty clinical services by 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.

Rural health centres and sub-centres provide services including management of chronic and acute conditions, basic surgical care, deliveries, and paediatric care, and function as intermediary referral points between aid-posts and district/provincial hospitals. The government more commonly runs the larger health centres which serve a population of 5,000 to 20,000. Health sub-centres deliver the same services as health centres. Urban health clinics provide similar services as health centres.

Rural aid-posts comprise more than 70% of all health facilities and deliver basic health care including mother and child care, and community-based health promotion and staffed by community health workers with two years training. Aid-posts are designed to cover a population group of about 1,000 people each.

The healthcare locations used in implementing this study were selected simply by convenience as there was inadequate funding and insufficient time to achieve a representative sample. Therefore, this study selected a rural health centre (LHC) which was relatively remote from a major hospital but served a large population. A provincial hospital (APH) which is in a small town, the capital of Milne Bay Province and accessible by the surrounding districts; and the only referral hospital (PMGH), evaluating the prescribing practices and drug supply management.

LHC served a population of more than 20,000 and is accessible by road or sea. Likewise, APH served a population of more than 200,000 and is accessible by air, sea or road. As outlined in the PNG HSDP [190]; the health centres are meant to serve a population of 5,000 to 20,000 and District/provincial hospitals cover a population of 40,000 to 300,000 depending on availability and accessibility of other health facilities

nearby. Therefore, these two settings were considered to reflect other health centres and provincial hospitals in PNG in-terms of population and accessibility.

7.1 Prescribing

Generally around the world, drug prescribing is an activity that is normally undertaken by medical and dental officers. However, in PNG due to the shortage of medical and dental officers; it is part of the health system that health extension officers, nurses, community health workers and dental therapists undertake diagnosis and drug prescribing. According to the data in this study, most of the drug prescribing (Table 3.5) at LHC which is a rural health centre was undertaken by CHWs (31.5%) and NOs (55.1%). At APH and PMGH which are urban hospitals, the drug prescribing was mostly undertaken by MOs and SMOs (61.3-95.0%).

When prescribers were grouped as non-medical and medical at each location, there was a significant difference between prescriber categories dependent on location. It is notable that there were very few patients for which prescribing was performed by Dental Officers, Dental Therapists or Resident Dental Officers (DO/DT/RDO).

At APH and PMGH (Table 3.6), inappropriate drug selection was at levels of 31.0% and 27.7% respectively where drug prescribing was mostly performed by medical doctors in these centres. At LHC (Table 3.6), inappropriate drug dosage and duration was at 18.4% and 11.4% and drug prescribing at this location was undertaken by CHWs and Nurses. The prevalence of inappropriate drug prescribing across all locations based on the guideline parameters of drug selection, drug dosage, drug frequency and drug duration combinations was 33.3%, ranging from 30.4% to 37.9% for the different centres.

Children received a higher number of inappropriate doses (Table 3.7) than adults and these were significantly different across the locations ($p<0.0001$). The “overall inappropriate” drug prescribing included the additional criterion of inappropriate item prescribed based upon legislative restrictions on non-medical prescribers. This gives the “overall” inappropriate prescribing levels of 33.4% for adults and 39.9% for children. It was 53.8% for children at APH.

7.1.1 Poly-pharmacy

With regard to the mean number of medications per prescription – which is intended to evaluate the degree of poly-pharmacy – the value found in the present study (2.3 drugs per prescription) is compatible with the WHO standards range of 1.6-1.8 [125]. In a series of studies conducted in other countries, the highest and lowest values found were 5.6 medications per encounter in India [191], 3.8 in Nigeria [192], 1.3 in Equador [131]; and 1.6 in Pakistan [193]. High numbers of medication give rise to non-adherence to treatment regimen and from drug-drug interactions.

The WHO has recommended that the average number of medications per encounter for outpatients should be 1.6 to 2.8 in developing countries [55]. The average number of western medicines per encounter in the THCs in Sichuan was four [194]. However, other developing countries, such as in Pakistan, also reported a slightly higher number of medications (average of four per encounter) prescribed by medical practitioners [195].

This study results indicated that there was no problem with regard to polypharmacy in PNG as compared to other developing countries.

7.1.2 Generic prescribing

In this study almost all of the medicines prescribed were prescribed generically. This finding falls within the WHO recommendation of 100% generic prescribing. This implies that the prescribers were complying with the PNG's essential drugs list and standard treatment guidelines as all drugs are listed in their generic names, although a trade name index is included in the MDC, most drugs are purchased on a tender.

While in other countries like Nigeria, about 50% of the medicines prescribed were generics [192, 196, 197].

7.1.3 Prescriber categories

The MDC provides a framework for prescriber categories. A wide range of drugs are included in category A which allows all health workers to prescribe. All other categories

relate to various levels of medical prescribing. There is also a category for pharmacist prescribing in community pharmacies which is outside the scope of this study.

These categories together with the STGs and MDC provide a sound public health system in PNG that if fully aligned could provide excellent prescribing outcomes. Unfortunately the current categories are not well aligned to the health system because of limitations to non-medical prescribers of a range of drugs that could treat patients in health centres without referral to a doctor at a provincial hospital. This includes treatment of simple hypertension and type 2 diabetes.

In the current distributed health system it is difficult for much of the population to access a hospital and the prescriber categories do not seem to recognise the limitations on access to medical care.

7.2 Antibiotics

In this study, 'antibiotics' refers to a broad range of treatments that are antibacterial, antifungal and anti-parasitic with the exclusion of antimalarial drugs.

Overall in this study, 58.4% of patients were prescribed antibiotics at their consultation. It is worth noting that prescribing of antibiotics is higher than the WHO recommended range of 20 – 26%. This figure could have been higher as it is strongly suspected, patients probably indulge in self-medication of personally purchased antibiotics whenever they suffer from a cough, or other ailments/infections since antibiotics are available over the counter in retail pharmacy outlets or on the streets. This study shows concerning high levels of overall prescribing and inappropriate prescribing by all prescribing groups. The small number of chronically ill patients found in the sample especially at LHC may arbitrarily increase the percentage of overall antibiotic prescribing, however this does not reduce the public health issues arising from the current prescribing data found in this study.

7.3 Malaria

In this study, 32.8% (358/1090) of patients who were prescribed drugs received an antimalarial drug and within each setting, the proportions of patients that received antimalarial drugs were; 48.6% at LHC, 40.9% at APH and 13.2% at PMGH.

There was a smaller proportion of patients at PMGH who received antimalarial drugs than the other centres. Possibly less patients with malaria go to the referral hospital and use other healthcare facilities in the public or private sector for their treatments.

A new STG was developed in 2009 which changed the guidelines that were used for this study. These guidelines included compound artemisinin products for uncomplicated malaria. These did not become available until 2011 when the drugs were distributed. It is possible some prescibers were aware of this change and moved to artemisinin products ahead of the change. New studies need to be undertaken to evaluate prescribing according to these new guidelines. It is unfortunate that the previous antimalarial drugs were not removed from stock when this change occurred.

7.4 PNG data on prevalence of chronic diseases

Non-communicable diseases (for example, cardiovascular disease, diabetes, chronic respiratory illness and renal disease) occur, the numbers reported are small to date [98]. Obesity is often considered a sign of wealth, and is likely to be linked to excessive consumption of Western foods rather than traditional foods. It is expected over the coming decade that non-communicable diseases will become more prevalent as a result of urbanisation, greater penetration of energy-rich Western foods and market goods to rural areas, increasing wealth in sub-sectors of the community, and a shift away from traditional lifestyles and traditional foods. Current hospital data does not yet show evidence of this. Cancer rates have remained the same over the past ten years. However, there is little capacity for diagnosing cancers, which may cause under estimation. There are now more people living beyond the age of 65, which leads to the likelihood of increasing burden of chronic disease and cancers in PNG [98]. In addition, with such a dispersed community, there could be an unknown level of undiagnosed chronic diseases.

Communicable diseases, including pneumonia, malaria, tuberculosis, diarrhoeal disease, meningitis and, increasingly, HIV/AIDS, remain the leading causes of morbidity and account for around 50% of mortality. Information on the true impact of HIV on mortality and morbidity in Papua New Guinea is lacking, but AIDS related death is now the leading cause of death in adult inpatients at the Port Moresby General Hospital [167].

Chronic non-communicable diseases such as cardiovascular disease, diabetes and asthma impose a growing health burden on developing countries [198, 199]. Chronic diseases are responsible for at least 50% of the deaths that occur in all World Health Organization (WHO) regions except Africa, where they still account for 25% of all deaths. While the proportion of deaths from chronic diseases is largest in high-income countries, in low- and middle-income countries chronic diseases continue to cause 39% and 72% of all deaths, respectively [200]. Cardiovascular disease alone accounts for 30% of all deaths in the world [200], 80% of which occur in low- and middle-income countries [198]. It has been estimated that an additional reduction of 2% annually in deaths from chronic conditions would avert 28 million deaths in low- and middle-income countries between 2005 and 2015 [201].

The incidence of non-communicable disease epidemic in Papua New Guinea is firmly established and increasing, but remains largely unrecognized in reported data [167]. Tobacco-related and alcohol-related illnesses, diabetes and hypertension are on the increase, as are the three leading cancers (oral, hepatic and cervical), along with breast and lung cancers [167].

In this study, about 11.5% were found to have been diagnosed or prescribed for chronic diseases such as hypertension and types 1 or 2 diabetes at LHC which is a rural health centre.

7.5 Standard treatment guidelines (STG) and EDL

The PNG STGs currently mainly cater for treatment of acute diseases and lack treatment management guidelines for chronic diseases such as gout, high blood pressure, or arthritis. Outlined in PNG HSDP [190], the rural health centres and sub enters should 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 current STGs although stating they relate to all prescribers including medical prescribers mainly include guidance on prescribing drugs which are in Category A (all prescribers). There are many drugs on the DMC limited to medical prescribing which are not included in the STGs. In most parts of the world STGs provide advice for all prescriber groups which is mainly medical prescribers. This raises a significant issue that no guidance is currently available for mainly of the drugs included in the MDC, especially those for chronic diseases and is a significant public health issue for PNG. This may also give rise to the purchase of drugs for inclusion in the MDC that would not selected if they were subjected to the rigorous process of inclusion in STGs.

7.6 Drug supply

As outlined in the PNGHSDP [190], securing essential drugs has historically been a major problem and availability of basic essential medical supplies in health centres rarely surpassed 60% between 1999 and 2010. This means health facilities typically go without many drugs for up to half the year. Government continues to implement reforms to improve procurement and distribution networks. Provincial transit stores have lacked adequate facilities to store and distribute medicines and vaccines. However, engagement of third party procurement and distribution channels for drug kits, supported by development partners, resulted in 83% availability of essential medicines for 2011. Initially kits were estimated to cover 40% of clinic catchment population needs this will progressively be enhanced to kits estimated to cover 100% of the population needs. Storage facilities at rural health centres and aid posts need to be upgraded for safe-keeping of drugs, vaccines, and intravenous fluids.

In this study, 86.5% of all drugs prescribed during the study period were provided hence 13.5% had problems with either no supply, over supply or under-supply (Table 3.9). This is above the WHO benchmark of 80% for medicine availability in a public healthcare location [202]. The study was undertaken during the period when the health centre had just received their drug supplies about four weeks earlier. It may have been

a different situation if the study was undertaken near the end of their drug ordering cycle.

Owing to longstanding drug shortages in many locations in PNG, it is unknown what impact this has had on appropriate prescribing as prescribing a drug not recommended in the STGs to circumvent a shortage has a potential to become habitual.

In addition, the reasons for oversupply and undersupply of items particularly antibiotics by dispensary was surprising. It is not from whether these were errors or responding to other pressures such as from patients or the potential for existing stocks to be exhausted prior to the arrival of the next supply. This, if it is occurring widely in PNG needs to be addressed.

7.7 Dispensing

As observed during the study, most of the drug dispensing at LHC was undertaken by CHWs and Nurses. Stat doses were given to patients at the health centre while the drugs to take home were given in a small envelope or plastic bag.

Liquid doses were given directly to the child while tablets were crushed in a medicine measure mixed with water and then given to the child. Possibly due to the slight bitter taste of the drug, it was observed that quite a number of children vomited the medicine at the clinic. The children STG in PNG states that “if a child vomits, give another dose of the drug”. Unfortunately, this did not always happen. This was an anecdotal report as the study design was not recording the frequency of this occurrence.

The label was hand written. If for example, a drug is to be taken 3 times a day, then a time slot of 6 am, 2 pm and 10 pm was written as to when the drug is to be given. Most times, the strength of the drug and other relevant information was not written on the label.

Advice given to patients on appropriate and effective use of medicines was always given in haste and this may have an effect on drug compliance. This is an example of poor communication between the dispenser and patient as highlighted by Sachs &

Tomson [143] in their study. Lack of communication between prescriber and patient was the main obstacle [203].

This occurrence is in agreement with an earlier study by Joshua and Sunderland [28] where most of the dispensing of drugs at the clinics was undertaken by nurses and community health workers. The tablets were placed in sealed paper envelopes with only the name of the drug written on it. Usually most drugs had no suitable labels with only the time indicated as to when to give it to the child. There has been only a slight improvement since that study was carried out.

The study by Hafeez et al. [204] carried out in Pakistan found dispensing practices are not satisfactory in public sector health facilities. The study by Karande et al. [205] conducted in India found inadequate labelling of drugs.

7.8 Injections

Injections are the most frequent medical procedure performed throughout the world. About 16 billion injections are administered each year in developing and transitional countries [206]. Overuse of injections not only increases the health care costs, but also increases potential spread of blood-borne viruses diseases and affects the quality of clinical care [207]. According to the WHO recommendation for the rational use of medications for outpatients in developing countries, the optimal proportion of injections should be 13.4% - 24.1% of total prescriptions [55]. In this study, the numbers of injections prescribed was low accounting for less than 9.3% of patient encounters. While prescribing of injections was lower than the recommended range of WHO (13.4–24.0%), a lower rate of injection prescribing of 7.5% has also been reported in Nigeria by Akande and Ologe [79].

The proportion of prescriptions with injections in Sichuan, China was 51.40%, far exceeding the WHO standard [194]. Worse than that, the proportion of multiple injections in one prescription was as high as 39.90% overall. These results reveal that the overuse of injections, particularly the excessive unrestricted use of multiple injections, has become a big problem at the rural healthcare facilities in Sichuan, China.

This overuse of injections was also reported in other developing countries in recent years, such as in Cambodia, India and Pakistan [208-210]. Some scholars speculated that the abuse of injections was inextricably linked to the medical consumption concept of the consumers [208, 211]. The finding of another study in Nigeria by Aghaji [212] show prescribing of injections was 26.9 %. There is still a popular belief in developing countries that injections are more convenient and effective than oral medications [194]. Since few people know about the pernicious consequences of injection overuse, it is very common that patients demand injection treatments for the purpose of quick recovery from sickness.

Therefore, as seen in this study, PNG has no problem with prescribing of injections as compared with those other developing countries.

7.9 Factors leading to inappropriate drug prescribing

The underlying factors leading to inappropriate drug prescribing are complex. They include societal and health system factors as well as education, training, continuing professional education and access to data [6, 29, 34, 40, 53, 101]. The guidelines used for this study were available to prescribers at each setting. Long queues of patients were a common occurrence in all settings increasing the stress on staff to manage these patients. The three locations evaluated in this study were all publicly funded institutions. Patients paid only a nominal fee which should not be a major barrier to access services. In LHC, isolation and a lack of doctors are major factors and ill patients may have significant transport difficulties to attend a provincial hospital. It was noteworthy that of the 356 patients evaluated in this study at LHC, only 11.5% were diagnosed or prescribed for chronic diseases such as hypertension, asthma and types 1 or 2 diabetes.

7.10 Interventions to address the inappropriate levels of prescribing

The interventions to address the inappropriate levels of prescribing need to be carefully considered prior to implementation. These would include reviews of the prescribing guidelines and their alignment with the medical and dental catalogue [66]. Currently methyldopa is stated in the guidelines as the only choice for hypertension, when enalapril is in the essential drugs list and only lifestyle changes for Type II diabetes

when metformin is in the essential drugs list. Since non-medical prescribers are the only ones available at health centres all over PNG and many of these are isolated from other services, this may include a review of the range of drugs that can be prescribed by non-medical prescribers, especially allowing broader access and updated treatment of hypertension and Type 2 diabetes. This could include a separation of the limitations into specific groups of non-medical prescribers.

The prescribing categories should be reviewed to ensure that current practice where appropriate was included with the standard treatment guidelines in PNG. For example, cloxacillin and indomethacin capsules were category B items and only medical prescribers were allowed to prescribe them but were available in the health centres where only non-medical prescribers were available.

It may be that the current group of non-medical prescribers may need to be differentiated within the prescriber categories. For example, HEOs are trained to a higher level of diagnosis and treatment than nurses and CHWs. That group following suitable education and training may then be allowed to treat a limited range of chronic diseases with clear indicators for when referral should occur.

8.0 CONCLUSIONS

The results indicate that the level of inappropriate prescribing in the selected locations in PNG was unacceptably high. These data have identified a level of inappropriate prescribing that has a potential to impact negatively on public health. The poor ability to determine appropriate doses in children by non-medical prescribers was a notable deficiency in their prescribing. Inappropriate selection of drugs by the medical prescribers not adhering to the guidelines is of great concern however some of this has arisen due to the current inadequacy of the STGs. The lack of alignment of the STGs and MDC is a major deficiency in the quest to achieve appropriate prescribing and therefore a major deficiency in public health. Support for medical prescribers, especially for the management of chronic diseases, in the STGs needs to be provided. This study has identified evidence of a high frequency of antibiotic prescribing and in addition inappropriate doses and durations which have a potential to increase antibiotic resistance. The lack of reliable resistance data and current advice on antibiotic selection is a major deficiency in managing patients, especially when much of the population has poor access to care. Current resistance data should overcome inappropriate prescribing arising from treatment failure. The current restrictions on prescriber categories do not match the STGs or MDC and need to be further considered in the management of selected chronic diseases.

The interventions to address the inappropriate levels of prescribing need to be carefully considered prior to implementation. These would initially include reviews of the prescribing guidelines and their alignment with the medical and dental catalogue [66]. Since non-medical prescribers are the only ones available at health centres and many of these are isolated from other services, this may include a review of the range of drugs that can be prescribed by non-medical prescribers. This could include a separation of the requirements for specific groups of non-medical prescribers. The determination of appropriateness of prescribing becomes complex since the relevant guidelines need to be adhered with but additional factors need to also be considered including workload, medication availability and prescriber category. Other interventions such as supervision/oversight of compliance to revised guidelines and publication of ongoing supervision/audit oversight reports need to be introduced as required. Ensuring the appropriateness of drug prescribing in the long term would greatly assist in effective

utilization of medicines, minimization of harm, and reduction of waste [213]. Therefore, appropriate interventions need to be introduced to address the underlying causes of the high level of inappropriateness of drug prescribing found in this study.

Although there have been revisions of all of the standards used in this study in 2012, it is noted that only minor changes have occurred and these would not markedly affect the data reported in this study. The study does need to be broadened to include other facilities to examine how general these finding are. It should also identify if there are particular characteristics of specific health centres and hospitals that influence prescribing. It is noteworthy that pharmacists have recently been appointed to many provincial hospitals and this study provides the need for them to be involved in studies and interventions to minimize the current level of inappropriate prescribing in their provinces.

9.0 LIMITATIONS OF THE STUDY

This preliminary study has investigated only three healthcare facilities at different levels in the health system in PNG. It would not be appropriate to generalize these data across PNG with the exception of PMGH which is the only major referral hospital in the country. Data were collected over a two week period and no reason was identified that this was different from any other period; no unusual epidemic or other change in illness pattern was evident at the time of data collection. However there is a possibility this could have occurred. Drugs supplies should arrive every two months for health centres and the analysis was done approximately four weeks after between the times scheduled when drug supplies arrive at all the locations evaluated. It is likely that drug shortages could increase towards the end of the delivery cycle perhaps influencing drug prescribing and supply.

10.0 RECOMMENDATIONS

- It is important that studies similar to this one are carried out at other centres to identify that these findings are typical across a range of centres in PNG.

- A complete review of the STGs needs to be performed that caters for all prescribers. Following that the MDC needs to be aligned with the new recommendations.

- A review of the management of chronic diseases is required as most of the population has limited access to medical care. This would then lead to possible changes to prescriber categories to align prescribing with the findings of the review.

- A review of the range of antibiotics commonly used and available in PNG needs to be performed for sensitivity to pathogens for which they are recommended, in relation to revised guideline recommendations.

- Establish a fixed ongoing review process of all treatment guidelines and align all supply procedures and appropriate prescribing authorities, to these guidelines.

- All treatment guidelines and supply procedures need to be widely promulgated and all health cadres be trained in their appropriate use.

- Education of non-medical prescribers on dosage calculation is essential to ensure that antibiotic under-dosing or over-dosing does not occur in children. Toxicity can occur from some antibiotics in over-dosage. For example, an over-dosage in gentamicin may lead to deafness. Therefore, suitable training and supervision programs need to be developed that will lead to a marked improvement in antibiotic prescribing by all groups of prescribers based on appropriately revised treatment guidelines.

- It is clearly urgent that PNG addresses these public health issues in a serious and coordinated fashion to minimize inappropriate prescribing, resistance to current and new treatments and reduce morbidity and mortality in the PNG population.

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Appendix 1: Patient information sheet

Data collection forms

Patients' information Sheet

This information sheet is for you to keep.

The School of Pharmacy, Curtin University of Technology is undertaking this research that is designed to evaluate the management of essential medicines in PNG.

There has been limited research carried out in management of essential medicines in PNG. An effective management system will ensure the availability of the right drugs in the right quantities, at the right time, for the right patient and at reasonable prices, and at appropriate standards of quality in hospitals and Health Centres. Despite the establishment of the PNG National Drug Policy and Regulations, access to essential medicines still remains a major health problem nation-wide. This study will assess the current process of management of essential medicines and will make recommendations to improve access to essential medicines in PNG. It is expected that this study will be of significance to PNG as it will develop a framework that conceptualizes the management of essential medicine process.

This study will take place over a specific period starting in April 2010 and has been approved by the Curtin University Human Research Ethics Committee. Confidentiality and security of the patient personal information will be guaranteed according to the guidelines of NHMRC/AVCC Statement.

Data will be collected via the prescription form and patient health card. The patient's drug treatments and current diagnosis will be collected. It will take 5 minutes of your time. All information collected will remain confidential and each form given a unique code. The names of the patients will not be recorded but given a code. The personalized information will only be known to the researcher. The results of the study will only be presented as compiled data and will not identify individual patients.

Participation in the project will not interfere or influence the treatments you are receiving which will be the standard care normally provided by the Hospital/HC. There is no requirement for you to participate and non-participation will not influence your treatment.

However, as the project is designed to improve patient access to essential medicines in hospitals and health centres, we would kindly request your participation.

Appendix 2: Participant consent form

PARTICIPANT CONSENT FORM

I have been well informed of the aims and significance of this research, and I know all the information I provide will be confidential. I will participate in the research voluntarily without any coercion or inducement. I guarantee all the information provided is correct and true. I understand I have the right to withdraw consent or further involvement in the research at any time without any negative consequences to my treatment.

Therefore, I give my support to the above criteria to participate in the evaluation of the management of essential medicines in PNG. This includes access to current diagnosis record.

Patient's Name:…….

Parent/Carer Name:……..

Address:…….

…….

Phone No:……..

Suburb/village:……

Patient/Parent/Carer Signature……

Date:……

……..

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Signature: ……. Date ……..

Appendix 3: Patient's prescription details

PATIENT'S PRESCRIPTION DETAILS

Code:…… Date:…… Adult / Age / DoB:……
Weight:…… Gender:……

Current diagnosis:
……
……
……
……..

Prescriber: SSMO☐ SMO☐ MO☐ HEO☐ NO☐ CHW☐ DO☐
Other☐(specify)……

Current medicines prescribed

(1) (a) Name:..... (b) dose:..... (c) freq:..... (d) duration:.....
(e)Total No. supplied.....

(2) (a) Name:..... (b) dose:..... (c) freq: ..... (d) duration:.....
(e) Total No. supplied.....

(3) (a) Name:..... (b) dose:..... (c) freq: : ..... (d) duration:.....
(e) Total No. supplied.....

(4) (a) Name:..... (b) dose:..... (c) freq: : ..... (d) duration:.....
(e) Total No. supplied.....

(5) (a) Name:..... (b) dose:..... (c) freq: : ..... (d) duration:.....
(e) Total No. supplied.....

Any injections given including total number supplied.
(1)……
(2)……
(3)……

Additional current chronic medication not required at this visit but still being taken by the patient.

(1) (a) Name:..... (b) dose:..... (c) freq:..... (d) duration:.....
(e)Total No. supplied.....

(2) (a) Name:..... (b) dose:..... (c) freq: ..... (d) duration:.....
(e) Total No. supplied.....

(3) (a) Name:..... (b) dose:..... (c) freq: : ..... (d) duration:.....
(e) Total No. supplied.....

List of drug items out of stock on the day prescribed.

(1) (a) Name:..... (b) dose:..... (c) freq:..... (d) duration:.....
(e)Total No. prescribed.....

(2) (a) Name:..... (b) dose:..... (c) freq: ..... (d) duration:.....
(e) Total No. prescribed.....

(3) (a) Name:.....(b) dose:.....(c) freq: :.....(d) duration:.....
(e) Total No. prescribed....

(4) (a) Name:.....(b) dose:.....(c) freq: :.....(d) duration:.....
(e) Total No. prescribed....

How out of stock items prescribed on the day were managed?

(1)......Substitute❒ Return when stock arrived❒ Never supplied ❒ Send to buy at local pharmacy❒

(2)......Substitute❒ Return when stock arrived❒ Never supplied ❒ Send to buy at local pharmacy❒

(3)......Substitute❒ Return when stock arrived❒ Never supplied ❒ Send to buy at local pharmacy❒

(4)......Substitute❒ Return when stock arrived❒ Never supplied ❒ Send to buy at local pharmacy❒

Appendix 4: Curtin University Human Research Ethics approval

Appendix 5: Article based on chapter 3 published in the Health Policy and Planning Online Journal