PRESCRIBING ERRORS AND INTERVENTION OUTCOMES IN SELECTED TERTIARY HOSPITALS IN NIGERIA

BY

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ABSTRACT

Prescribing errors, particularly in the medical and paediatric specialties have been reported globally to affect up to 52.0% of hospitalized patients with potential to cause harm. Prescribing errors have however not been adequately investigated in Nigeria. This study was designed to carry out an in-depth evaluation of the nature, severity and causes of prescribing errors in three purposively selected tertiary hospitals in Nigeria with a view to providing pharmacist-led evidence-based recommendations for their prevention.

A retrospective review of 8270 out-patient prescriptions and 1200 in-patient records from medical and paediatric units between January and December 2010 in National Hospital, Abuja (NHA) with University of Abuja Teaching Hospital, Gwagwalada (UATH) and University College Hospital, Ibadan (UCH) as controls. Baseline prescribing pattern was measured using the British National Formulary and Nigeria Standard Prescribing Guidelines. Causes of prescribing errors were investigated using a prospective qualitative approach involving semi-structured face-to-face interviews and questionnaires guided by the Reason's accident causation model. Error rates were studied in the three tertiary hospitals while intervention was carried out at NHA. Interventions involved educational outreaches consisting of structured teaching and training. Data collected compared error rates pre- and post- intervention, to determine impact of the intervention. Data were analysed using descriptive and Chi-square statistics.

Prescribing error rates were 24.6 ± 1.4 (UATH), 5.7 ± 1.2 (NHA) and 6.7 ± 2.3 (UCH) for out-patient prescriptions and 28.7 ± 2.3 (UATH), 26.3 ± 2.1 (NHA) and 41.0 ± 3.1 (UCH) for in-patient prescriptions. Non-inclusion of direction of use (38.1%, UATH); missing signature and/or name of prescriber (66.6%, NHA) and omitting end date of therapy (54.4%, UCH) were the commonest errors in out-patient prescriptions. The most common in-patient prescribing error was missing end date of therapy: 71.3% (UATH), 65.9% (NHA) and 86.0% (UCH). The highest proportion of medications was ordered at admission: 57.3% (UATH), 44.3% (NHA) and 44.7% (UCH) while time of discharge was associated with the highest error rates of 37.8% (UATH), 58.6% (NHA) and 80.8% (UCH). Severity of prescribing error rates for in-patients was 4.9% (UATH), 2.8% (NHA) and 1.3% (UCH). Prescriptions involving antimicrobials contained the highest prescribing

errors 53.8% (UATH), 37.9% (NHA), and 36.3% (UCH). Risk factors identified in error causation included organisational (91.0%), environment (50.0%), individual (45.0%), task (45.0%) and team (36.0%) factors. Absence of self-awareness of errors and organisational factors identified included inadequate training and experience and absence of reference materials. Defences against errors, particularly pharmacists' involvement, were deficient. There was no change in overall error rates 5.8%, pre- and post- intervention ($p = 0.98$). However, there were reductions in drug-drug interactions 1.2% to 0.4% ($p<0.001$), omission of drug route 0.3% to 0.1% ($p<0.001$) and ambiguous orders 0.2% to 0.0% ($p<0.001$) at the NHA.

Prescribing errors were common in the 3 facilities resulting from writing prescriptions that lacked details and slips in attention. Majority of the errors, though of minor severity, had potential of causing harm. Continuing prescriber education and training will likely result in error reduction. Pharmacists' involvement in prescribing error prevention should be an on-going process.

Key words: Prescribing errors, Reason's accident causation model, In- and out-patients.

Word count: 500

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Finally, to my Father, the Eternal God, the Almighty, the Unchanging Changer, my Pillar, the Divine Consultant, my Glory and the Lifter-up of my head, be all the glory.

CERTIFICATION

We certify that this work was carried out by Adetutu Adebambo Ajemigbitse in the Department of Clinical Pharmacy and Pharmacy Administration, University of Ibadan

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LIST OF ABBREVIATIONS

ADR	Adverse Drug Reaction
A&E	Accident and Emergency unit
b.d	twice a day (bis die)
BNF	British National Formulary
Caps	capsules
CBC	Complete Blood Count
CKD	Chronic Kidney Disease
Cr Cl	Creatinine Clearance
CVS	Cardiovascular system
ED	Emergency Department
EOV	Education outreach visit
g	gramme(s)
h	hour(s)
HIV	Human Immunodeficiency Virus
HO	House Officer(s)
hrly	hourly
IM	Intramuscular
L	Litre(s)
I.U	International units
IV	Intravenous
IVF	Intravenous fluid(s)
KBM	Knowledge-based mistakes
mg	milligram
min	minute(s)
mmol	millimoles
nocte	at night
NHA	National Hospital Abuja
NSAID	Non – steroidal anti-inflammatory drug(s)
o.d	once a day (omni die)
ORS	Oral rehydration salts
p.r.n	when required (pro re nata)
q6h	Every 6 hours
q.d.s	four times a day (quarter die sumendus)
®	Trade mark
RBM	Rule- based mistakes
Reg	Registrar
SC/subcut	Subcutaneous
SPSS	Statistical Package for the Social Sciences
SR/SReg	Senior Registrar
stat	Immediately
t.d.s	three times a day (ter die sumendus)
UATH	University of Abuja Teaching Hospital
UCH	University College Hospital
U.K	United Kingdom
US/ USA	United States of America
UTI	Urinary Tract Infection
WHO	World Health Organisation

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

A prescription is defined as an order written by a registered physician, dentist or other certified health personnel to a qualified pharmacist or appropriate personnel for the purpose of supply of an ordered medication. A prescription is a legal document that should be treated with utmost care. According to the 2008 Nigeria Standard Treatment Guideline produced by the Federal Ministry of Health, essential elements of a prescription order are the following-

- **Identity of prescriber** including name, signature, telephone number and address/institution of prescriber
- **Date of prescription**
- **Identity of patient** including name, age (esp. in children), gender, hospital number and address of patient
- **Elements specifying medication** such as

- Name of medication
- Strength and quantity
- Dosage
- Frequency
- Duration
- Directions for use
- Refill instructions
- Additional labeling instructions

The guideline also states that only standard official abbreviations should be used. Examples are o.d, b.d, p.r.n, q.d.s, t.i.d, stat. Any deviation from the above specifications would constitute an error or weakness which should be corrected.

Errors made during drug prescribing are the most common type of avoidable medication errors and hence are an important target for improvement (Dean, 2002; Barber et. al., 2003). In the past, the response to prescribers' mistakes has been to focus on the individual's behaviour whatever the circumstances. However, prescribing errors made by doctors are influenced by various objects within the prescribing environment. Findings of studies of industrial errors and human psychology have resulted in the development of frameworks to analyse the causes of errors and to suggest solutions. James Reason (1990, 1995) developed one such framework which has gained acceptance in medical research. This has been applied to medical errors and is the theoretical basis behind this study.

Initiatives to promote rational use of medicines and to reduce the number of serious errors involving prescribed drugs have been embarked upon in many countries and have also come into focus in Nigeria's health institutions.

Multifaceted approaches incorporating educational outreach visits have been reported to be generally effective in improving prescribing when compared with no intervention. Mixed effects have however been observed for educational outreach as a single intervention. Even the World Health Organisation (WHO) has addressed the problem of careless prescribing, by publishing a guide to rational prescribing (De Vries et. al., 1994). To achieve such reduction in mistakes, the causes of errors need to be understood and interventions developed that will work for the types of prescribers, existing conditions and setting. The effectiveness and sustainability of such interventions should be investigated.

Improvement in prescription writing will improve the efficiency of the whole system resulting in pharmacists, nurses and other clinicians being able to do their work quickly, with more appropriate use of drugs and less time spent sorting out avoidable problems. There would be more effective use of healthcare and patients will ultimately benefit from this.

1.2 Statement of the problem

The interaction between a physician and patient usually culminates in the writing of a prescription order. The time, skills and energies put into making a diagnosis and deciding on an appropriate therapy could be undermined if adequate attention is not given to the details that ought to be included in a well-written prescription. A prescription should clearly communicate with a pharmacist or dispenser what therapy a particular patient is to get: how much of a specific medicine should be taken, how often and for how long. It should also clearly identify the prescriber, be signed in ink and be dated (British National Formulary, 2013). The illegibility of the prescription or the omission of any of these details in a prescription order could result in misinterpretation, medication errors and adverse drug events.

Despite the volume of studies on medication errors, the majority of which are prescribing errors, these have continued to be recognized as an important cause of harm to hospital patients. Much of the published work documenting the rates and types of medication errors occurring in hospitalized patients, come from North America and the United Kingdom. Very few have been carried out and published or reported in the Nigerian setting.

Previous studies carried out in the Nigerian hospital setting reported that prescribing errors were common though may not always result in actual adverse outcomes for patients (Erhun et. al., 2009). In the few studies examining the quality of prescribing by Nigerian medical practitioners, there appears to be a need to improve prescribing quality (Akoria and Isah, 2008). Junior doctors, being the most frequent prescribers in the hospital setting have been reported to make most of the prescribing errors (Oshikoya, Senbanjo and Amole, 2009). As it is not easy to change the prescribing habits of experienced doctors, there is the hope that educating junior doctors to prescribe according to a standard guideline may be a more effective intervention. Patients and other healthcare givers will ultimately benefit from this.

1.3 Justification of study

Accurate medication prescribing is an important process in ensuring the best possible outcomes in the treatment and management of diseases. While dispensing errors can also result in significant patient harm, prescribing errors are rife in the hospital setting

worldwide though there has been relatively little research in this area in developing countries. A review of literature shows a handful of descriptive studies looking at prescribing errors in out-patient settings. Such studies from Nigeria reported a high incidence of errors in prescription writing including incomplete prescribing information, non-adherence to national formulary, failure to use generic names of medicines amongst others. Solutions such as computerized physician ordering systems and electronic prescription writing programs have been used to address these issues in the developed nations. In developing countries however, these solutions are not feasible due to resource constraints.

In developing specific strategies to improve prescribing in our environment, it is important to first understand the nature, types, prevalence and causes of prescribing errors that frequently occur. This research aimed at identifying the causes of and factors associated with prescribing errors in three tertiary hospitals in Nigeria, collate, analyse, and synthesize findings from it using the Reason's model so as to make it easier to link our conclusions with previous publications. Subsequently, formulate an intervention to minimize or prevent prescribing errors and test the effectiveness of the intervention by showing statistically significant changes (where evident) in prescribing error rates following the intervention. Because of the lack of prior published evidence about the causes of prescribing errors (and efficacy of interventions) in the Nigerian setting, it is hoped that recommendations ensuing from this study will provide a base for further exploratory research.

1.4 Main objective of the study

This study focused on identifying the nature and types of prescribing errors, analyse factors underlying these errors with a view to developing a specific intervention and providing evidence-based recommendations to improve patient safety and set standards of care to which our prescribers can adhere.

1.5 Specific objectives:

1. To measure types and prevalence of medication prescribing errors
2. To determine the severity or clinical significance of the identified errors
3. To explore when in the prescribing process errors occur
4. To determine the types of medicines associated with these errors

5. To identify the prescribers whose prescription writing skills failed to meet accepted standards
6. To identify factors underlying poor prescription writing and prescription errors.
7. To formulate intervention strategies based on the identified causes
8. To determine the impact of an intervention on prescribing error rate.

It is against this background that the study sought to answer the following research questions.

1.6 Research Questions:

1. What are the types and prevalence of prescribing errors in both out and in-patient prescriptions in three selected Nigerian tertiary hospitals?
2. What is the severity of prescribing errors observed?
3. When in the prescribing process for hospitalized patients, are errors most likely to occur?
4. What types of medications are involved in prescribing errors?
5. Which are the prescribers whose prescription writing skills failed to meet accepted standards?
6. Using the Reason's model, what are the factors underlying errors in prescription writing?
7. What will be the effectiveness of an intervention on reducing prescribing errors?

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of medication errors

Poor quality prescribing has been identified as one of the leading causes of medication error and adverse drug events (Gommans et. al., 2008).The United States of America National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) defines a medication error as follows: '*A medication error is any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient or consumer'*. Such events may be related to professional practice, health care products, procedures and systems including – prescribing, order communication, product labeling, packaging and nomenclature, compounding, dispensing, distribution, administration, education, monitoring and use. Medication errors may lead to actual or potential adverse events.

It has been estimated that 1-2% of patients admitted to both UK and US hospitals are harmed as a result of medication errors the majority of which can be attributed to prescribing errors (Barber and Dean, 1998; Neale et al., 2001; Barber et al., 2003) and hence are an important target for improvement. Prescribing errors, independent of whether they cause harm, are common. This was the emphasis in the 2004 document of the UK Department of Health 'Building a safer NHS for patients -improving medication safety' which recommended ways to reducing prescribing errors and hence this burden of harm. Lewis and colleagues (2009) in a systematic review, found a median prescribing error rate of 7% of medication orders, 52 prescribing errors per 100 admissions and 24 prescribing errors per 1000 patient days.

Many specific factors have been associated with prescribing errors, including medication dosage forms (Fijn et. al., 2002), dosage errors (Oshikoya and Ojo, 2007),

illegible prescriptions (Sanguansak et. al., 2012), incomplete prescribing information (Erhun et. al., 2009), prescriber characteristics (Fijn et. al., 2002), poor patient history taking (FitzGerald, 2009), time of day (Beckett et. al., 2012) and incomplete prescriptions or failure to observe prescribing standards (Bates and Gawande, 2003; Ogden and Lakhani, 2008; Condren et. al., 2010).Understanding the many factors which contribute to errors would assist in the implementation of effective strategies for error prevention.

2.2 Incidence rates of medication prescribing errors in hospitals

Weingart et. al. (2010) in a study to determine medication errors in oral chemotherapy which involved collection of error incident reports from 14 cancer centers among other sources, classified the type of incident, severity, stage in the medication use process, and type of medication error. The most common medication errors reported involved wrong dose, wrong drug, wrong number of days supplied, and missed dose. Similarly, prescribing errors in HIV medication orders have been reported to have significant potential to cause harm. The consequence of serious medication errors with antiretroviral drugs (ARVs) are virological failures, development of resistant virus or drug-related toxicity with varying levels of harm to the patient. In evaluating the incidence, types and severity of prescribing errors in a HIV outpatient clinic, Ogden and Lakhani (2008) found out that prescribing errors were common, occurring at a rate of 8.7%. The study, which was a prospective assessment of HIV outpatient prescriptions in a UK hospital, reported that unclear prescriptions were the commonest type of error while dose and frequency errors accounted for serious errors with ARVs. Though carried out in a single hospital, the study highlighted the role of specialist pharmacists in preventing the majority of errors from reaching patients (near misses).

In 2006, Stubbs and colleagues reported on a one week prospective audit of prescribing errors in an inpatient setting. Over twenty thousand (22,036) psychiatric medication handwritten prescriptions were reviewed, and found 523 errors (77.4% writing errors and 22.6% decision making errors). All errors were self-reported. The authors concluded that 4.3% of the total errors could have caused serious harm or death.

Bowers et. al. (2009) monitored prescription charts and discharge prescribing forms in a 24-bed British adult psychiatric inpatient unit prospectively for 6 weeks. Education for psychiatrists and nurses on medication error detection intervention were provided pre and post intervention. Initial monitoring detected 93 prescribing errors out of 407 prescribing orders, over six weeks. After education on medication errors at two local academic meetings, 66 prescribing errors out of 622 prescribing orders were detected. The authors reported errors in medication choice, in prescription writing such as illegibility and spelling errors and in transcription.

Prescribing errors are not limited to the adult population. Researchers have reported prescribing errors in the paediatric population. In a retrospective random selection of paediatric outpatient prescriptions at a Nigerian teaching hospital, Oshikoya and Ojo (2007) reported that errors were common and mainly identified inadequate medication dosing, omission of age, dosage, duration of drug use and improper dosing and prescribing of those drugs that could adversely interact. Errors of overdosing and under dosing were common to most of the commonly prescribed drugs. Under dosage and over dosage were associated with 2518 (38.0%) and 1247 (18.8%) drugs respectively, while inadequate and omission of the duration of use of the drugs were observed in 1981(28.3%) and 61(0.9%) prescriptions respectively. Errors in the calculations of paediatric doses in mg/kg for both tablets and liquid dosage forms were reported to be significant. Walsh and colleagues (2008), who evaluated the effect of computerized physician order entry (CPOE) system on rate of inpatient paediatric medication orders, reported a reduction of about 7.0% in this population after the introduction of the system. However, their study showed no change in the rate of injuries as a result of errors. The efficacy of the CPOE in reducing error rates ranging from 17.0% to 81.0% have been reported (Bates et. al., 2001; Gandhi et. al., 2005; Donyai et. al., 2008). A limitation of the CPOE system is that it is not yet widely used nor adopted in many hospitals outside the USA and UK. It is important that interventions which are reported to be effective in changing prescribing do so in ways that optimize patient outcomes while minimizing healthcare costs especially for resource-limited settings.

On the other hand, Rinke et. al. in 2008 studied prescribing errors in a paediatric emergency department at a US- based hospital by retrospective review of patients'

charts and ambulatory prescriptions. They reported that 12.5% of the in-patient orders and 19.4% of charts contained at least one error. These included incorrect doses, and incorrectly written prescription orders. Interestingly, the study checked for prescriber identification and reported that paediatric postgraduate year-3 residents had the highest in-house order incorrect dose error rate (3.5%), and emergency department (ED) paediatric postgraduate year-2 residents had the highest ambulatory prescription incorrect dose error rate (9.1%). Paediatric ED attending physicians had the highest error rates for writing orders and prescriptions incorrectly, 25.0% and 9.7%, respectively. Antibiotics, analgesics, and narcotics were most often involved in the errors.

In a study to assess errors in analgesic controlled-substance prescriptions in a paediatric hospital, Lee et. al. (2009) prospectively observed prescriptions and discharge forms of 241 pediatric patients discharged from an urban teaching hospital. Common prescription errors as determined by the study criteria were: missing or wrong patient weight, incomplete dispensing information, and wrong or no date on prescriptions. Almost 3.0% had the potential for significant medical injury and were considered potential adverse drug events. The authors remarked that discharge prescription errors for children requiring potent, opioid analgesic drugs in the management of pain are common, with nearly 3.0% capable of causing significant harm. The authors concluded that the high rate of prescribing errors observed in the study highlights the importance of developing, testing and implementing effective error-prevention strategies, especially in high-risk medications such as narcotics.

Likewise, Condren et. al. (2010) retrospectively reviewed records of patients in a paediatric acute care clinic. Out of a total of 3523 records, prescribing errors were found in 175 prescriptions (5.0%). They reported that the most common type of error was an incomplete prescription (42.0%), followed by dosing errors (34.0%). Anti-infectives were most commonly written in error followed by anti-inflammatory agents. They concluded that recognizing the types of errors would be beneficial for developing educational programs intended to decrease prescribing errors and recommending improvements.

Prescribing errors are reported to occur commonly with antimicrobials, as well as in adult's prescriptions. This observation was made by Lewis et. al. (2009) who carried out a systematic review of studies on incidence and nature of prescribing errors in hospital in-patients. Most of these studies were conducted in the US or UK and originated from single hospitals. This review collaborated the perception that incorrect medication dosage was the most common prescribing error type with up to 7.0% of medication orders being affected. However, the reported rates of prescribing errors varied greatly and this could be partly explained by variations in the definition of a prescribing error, the methods used to collect error data and the setting of the study. Furthermore, a lack of standardization between severity scales prevented any comparison of error severity across studies. The reviewers recommended that future research should address the wide disparity of data-collection methods and definitions that bedevils comparison of error rates or meta-analysis of different studies.

2.3 Defining prescription errors and balanced prescribing

'Prescribing' is defined as (i) the process of deciding what to prescribe and naming it and (ii) the act of writing the prescription. 'Prescription' is (i) the act of writing a prescription and (ii) the prescription itself. Because of this ambiguity, it is best to use 'prescribing' to mean the decision making process and 'prescription' the act of writing the prescription (Aronson, 2009).

Various types of faults can occur in the decision-making process: irrational prescribing, inappropriate prescribing, overprescribing and ineffective prescribing. These form a class of errors, but are different in type from the class of errors that can be made in the act of writing a prescription. The term 'prescribing errors' ambiguously encompasses both of these (Aronson, 2009).

In order to describe prescribing error rates as a meaningful component of clinical governance and compare data from different studies, a clear definition of prescription error, useful as a common foundation for research work and practice is needed. Dean et. Al. (2000) developed a definition of prescribing error using the Delphi technique (Cantrill et. al., 1996) which is a survey technique for decision making among isolated respondents. Accordingly, a clinically meaningful prescribing error was defined as *a prescribing decision or prescription writing process that results in an unintentional,*

significant (i) reduction in the probability of treatment being timely and effective or (ii) increases the risk of harm when compared with generally accepted practice.

This definition embodies errors such as prescribing without taking the patient's clinical status into account, lapses in communicating essential information, not taking account of a potentially significant drug interaction, prescribing the wrong medicine, wrong strength, wrong dose, wrong time, wrong patient or wrong route of administration, poor or illegible handwriting, omission of prescribers signature and transcription errors such as from one treatment sheet to another. However, this definition rules out prescribing faults that do not result in harm, and overlooks the fact that it is desirable to detect and examine all errors, whether 'clinically meaningful' or significant, since an error indicates a weakness in the system, which might on a future occasion, lead to an error of clinical relevance. See Appendix A for Dean's list of events that constitute a prescription error.

A prescription is 'a written order, which includes detailed instruction of what medicine to be given to whom, in what formulation and dose, by what route, when, how frequently, and for how long' (Aronson, 2006). Thus a prescription error can be defined as 'a failure in the prescription writing process that results in a wrong instruction about one or more of the normal features of a prescription'. The 'normal features' include the identity of the recipient, the identity of the drug, the formulation, dose and the route, timing, frequency and duration of administration (among others). In an attempt to unify the various types of prescribing faults into a single definition of their opposite, Aronson (2006) developed a term, 'balanced prescribing', defined as 'the use of a medicine that is appropriate to the patient's condition and, within the limits created by the uncertainty that attends therapeutic decisions, in a dosage regimen that optimizes the balance of benefit to harm'.

2.4 Medication prescribing cycle for patients

The medication ordering sequence for both out and in-patients is complex and hence the possibility of errors is increased.

In the traditional paper chart model prevalent in the Nigerian setting, a prescriber evaluates a patient's condition and writes an order in the medical notes. Before doing this, the prescriber interviews the patient, reviews the medical history, reviews drug

allergy, considers laboratory data, considers probable adverse drug reactions and attempts to match the patient's symptom profile with the patient's predisposition to develop certain side effects with the selection of a medication. The order is subsequently transcribed into the treatment sheet or out-patient prescription form.

The prescribed medication order is then sent to pharmacy for screening, costing and recording into the pharmacy record system. Subsequently, the medication is dispensed in the pharmacy, or collected and taken back to the ward, where the medication is administered to the patient on the basis of the order, documented and an assessment of the medication's effect on the patient is undertaken. This sequence has multiple subcomponents and seemingly innocuous errors can result in patient harm. Some researchers have stated that somewhere between one fifth and one quarter of errors may be intercepted and corrected before drugs are administered to patients (Bates et. al., 1995)

2.5 Cost of Errors

In 2000, the US Institute of Medicine report *To Err is Human: building a safer health system* estimated that preventable healthcare-related injuries cost from US$17 to $29 billion annually. In a study of medical errors in a large teaching hospital, the annual cost of errors was estimated at $5 million (Bates et. al., 1997). The same study estimated that the total annual cost of errors in all acute care facilities was $20 billion.

Although human errors are often the immediate cause of medication errors, the majority of errors are due to system failures precipitated by the increasing complexity of patient care. Initiatives to reduce the number of serious errors involving prescribed drugs have been proposed (U.K Department of Health Expert group on learning from adverse events in the NHS: 'An organization with a memory', 2000).

2.6 Classification of medication errors and risk management

The best way to understand how medication errors happen and how to prevent them is to consider their classification, which can be contextual, modal or psychological (Aronson, 2009). Contextual classification deals with the specific time, place, medicines and people involved. Modal classification examines the way in which error occur (e.g. by omission, repetition or substitution). However classification based on

psychological theory is preferred, as it explains events rather than merely describing them.

Psychologists consider an error to be a disorder of an intentional act, and they distinguish between errors in planning an act and errors in its execution. If a prior intention to reach a specific goal leads to action, and the action leads to the goal, all is well. If the plan of action contains some flaw, that is a 'mistake'. If the plan is a good one but is badly executed, that is a failure of skill.

Models of accident causation are used for the risk analysis and risk management of human systems. Many have gained acceptance and use in health care. The Reason's model of accident causation is the most commonly used theoretical model when considering prescribing errors (Reason 1990, 1995 and 1997; Dean et. al., 2002a; Coombes et. al., 2008; Lewis et. al., 2009). A brief explanation of this model is given below:

2.6.1 The Reason's model of accident causation

James Reason hypothesizes that most accidents can be traced to one or more of four levels of failure-

- Organizational influences
- Unsafe supervision
- Pre-conditions for unsafe acts and
- The unsafe acts themselves

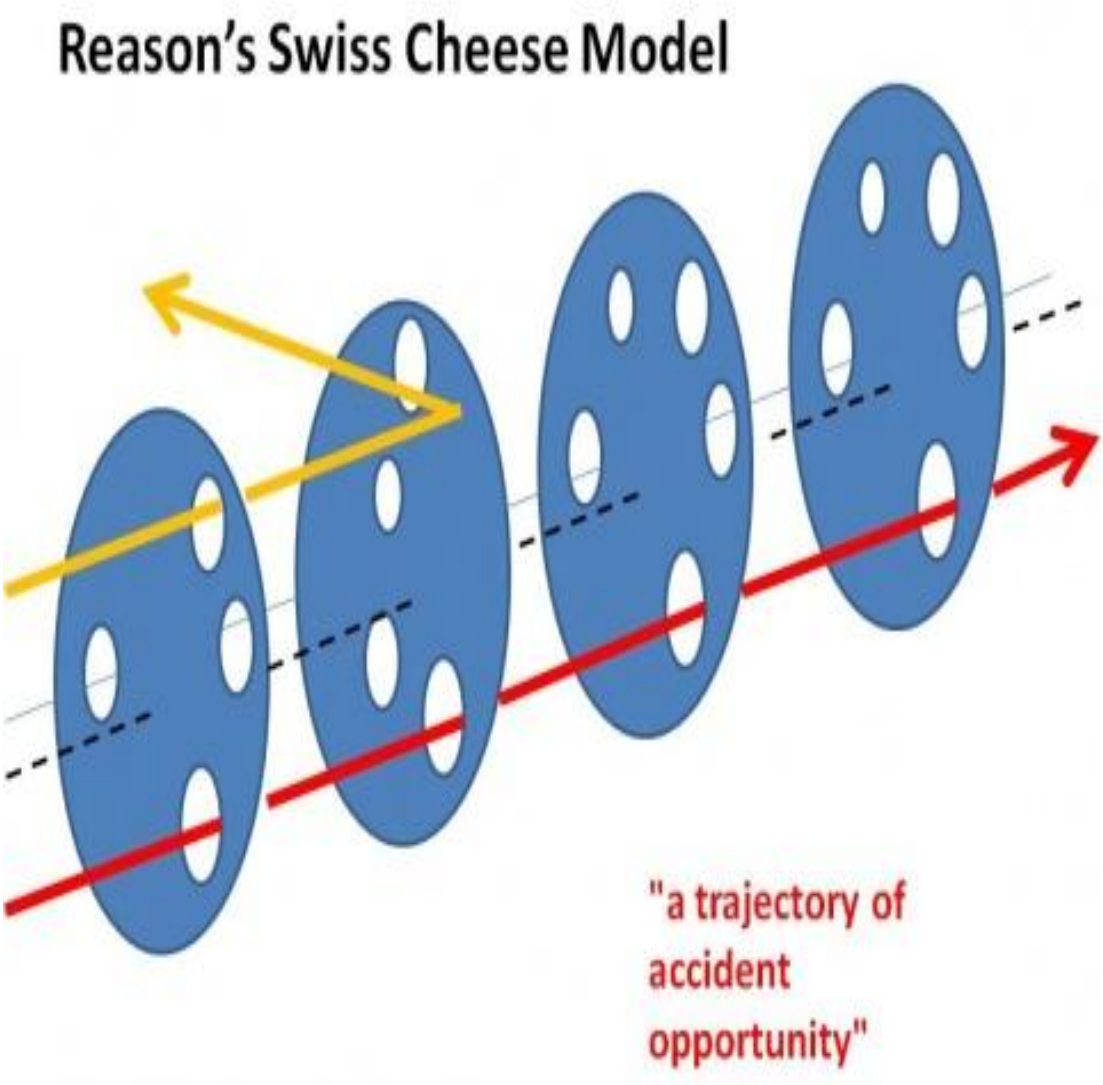


Figure 2.1: Reason's Swiss Cheese Model (Reason, 1997)

In this model, an organization's defences against failures are modeled as a series of barriers with individual weaknesses in individual parts of the system. The system as a whole produces failure when all individual barrier weaknesses align permitting a 'trajectory of accident opportunity' so that a hazard passes through all of the holes in all of the defences, leading to a failure or accident (Reason, 1995, 1997, 2000). The Reason model contends that to eliminate problems, one cannot simply focus on the individual's behaviour, rather to look into the indirect, underlying factors and causes which may be the root of the problem. In essence, he postulates two inter-related pathways that lead to an accident or error-

1. An active error pathway that originates at top level decisions, proceeding through error-producing factors in the work environment to unsafe acts committed by the individual at the human system interface
2. A latent error pathway that directly breaches the defences in a system

The diagram below depicts the 'error pathway' based on the Reason's psychological approach.

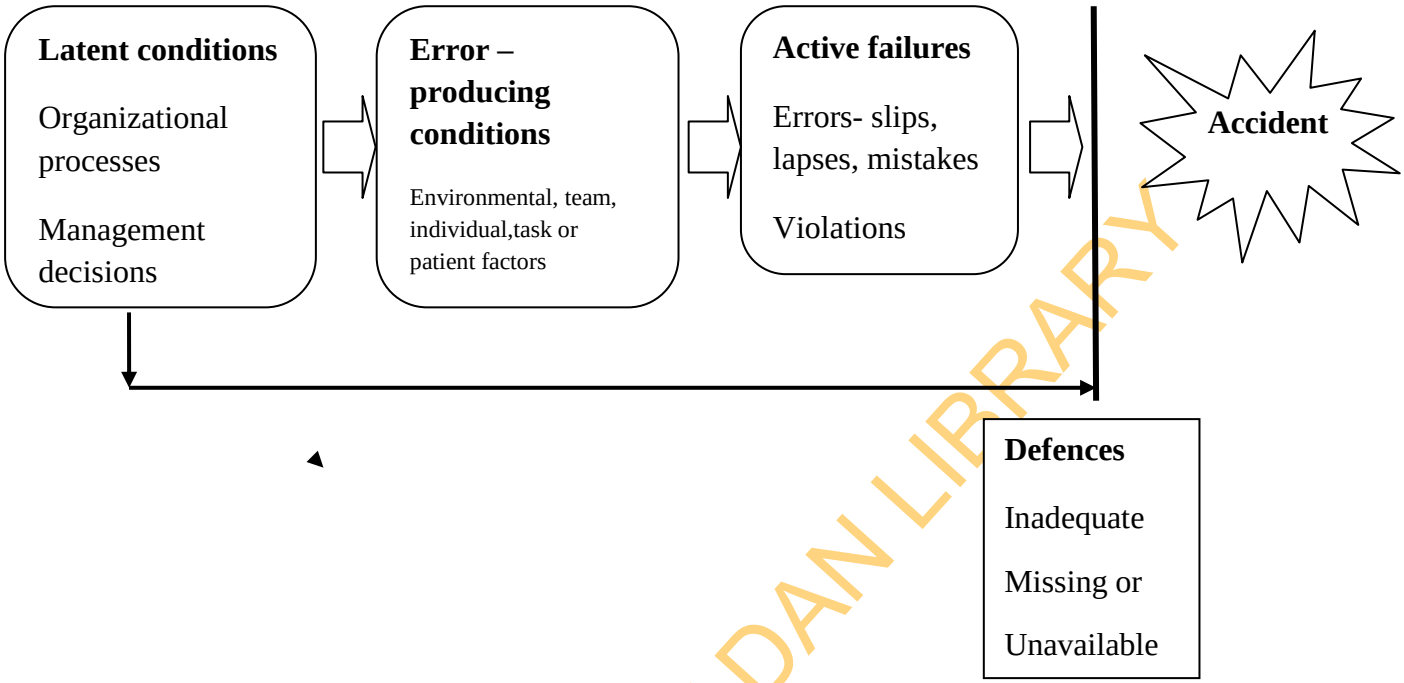


Figure 2.1: Modified Reason's Accident Causation Model (Dean et. al., 2002a)

Latent conditions- that affect the environment to a wider level leading to error producing conditions such as

- organizational processes – workload, prescription design
- management decisions- staffing, inadequate provision of training/support for junior staff.

Error producing conditions such as environmental, team, individual or task factors that affect performance, resulting in active failures- including lack of training or experience, fatigue, stress, high workload for the prescriber and inadequate communication between healthcare professionals.

Active failures such as errors, slips, lapses, mistakes and outright violations.

Errors- failure of a planned sequence of actions to achieve desired goal either because an adequate plan was incorrectly executed (skill-based slips or memory-based lapses) or because an inadequate plan was made (rule-based or knowledge based mistakes)

Slips- actions in which there are recognition or selection failures; such as writing a prescription for chlorpromazine when chlorpropamide is wanted due to attentional failure

Lapses- failure of memory or attention; errors due to omission of a particular task such as forgetting to write the time of day to take a medication

Mistakes- incorrect choice of objective, or choice of an incorrect path to achieve it due to inadequate knowledge of the drug or the patient such as giving a drug by IV infusion in a medium that interacts with the active drug even though attention was paid to the right dose, right duration etc

Violations - intentional deviations from normal rules and procedures such as instances in which rules of correct behaviour are consciously ignored.

Accidents- result as a consequence of the above three conditions. Consequently, defences are needed.

Defences- are designed to protect against hazards and mitigate consequences of failure. Defences may or may not be adequate as a result of latent conditions.

Defences could be within the prescriber's own internal thought process or provided by pharmacists or nurses. Pharmacists play a key role in the defences against errors as they provide a supply role and also monitor prescriptions to detect any errors that arise. Doctors could also improve their own defences by recognizing instances in which they might make errors; for example when looking after another doctor's patients', having an unusual heavy workload and when dealing with unusual drugs (medicines).

James Reason categorised errors into two main types; those that occur with the failure of execution of a good plan and those that arise from correct execution of an inappropriate or incorrect plan. The former are termed slips or lapses. Memory lapses are errors due to omission of a particular task. Slips and lapses occur at what has been termed the skill-based level of performance and occur during what are often automatic and routine tasks requiring little cognitive input.

Errors that occur due to the correct execution of an inappropriate or incorrect plan are termed mistakes. These mistakes are of two types; rule-based mistakes (RBMs) and knowledge-based mistakes (KBMs). RBMs occur when the person making the error has some familiarity of the task at hand due to experience or training and can draw on rules that he or she has applied in the past. Mistakes occur when a normally good rule is misapplied, such as the failure to spot that a patient has a contraindication to a particular treatment. They can also occur when the rule applied is a bad rule or when individuals fail to apply a good rule.

KBMs take place at a higher conscious thought processing level and are related to any type of knowledge- general, specific or expert. These occur when the person performing a task has to consciously think about how to carry out the task. This level of performance is used when a task is novel to the person and they have no previous stored rules that they can apply to carry out the task. For instance, it is general knowledge that penicillins can cause allergic reactions: knowing that your patient is allergic to penicillin is specific knowledge, knowing that co-fluampicil contains

penicillins is expert knowledge. Ignorance of any of these facts could lead to a knowledge-based error.

Slips, memory lapses, RBMs and KBMs are all unintentional errors. When deviations from normal rules and procedures are intentional then these are termed violations. Violations are often related to motivation and work environment. Three types of violations are discussed by Reason. These are (1) routine violations- which occur when individuals believe that they have enough skill to break rules and this can be done in order to save time; (2) situational violations- occurring when the local environment makes following the rules difficult or impossible; (3) optimising violations- which occur for personal gain, such as deciding to break a rule to demonstrate skill at a particular task (Parker and Lawton, 2006).

2.7 Preventing errors through classification

This classification can help understand how errors can be prevented (Ferner and Aronson, 2006). Knowledge-based errors can be prevented by improving knowledge such as ensuring that students are taught the principles of therapeutics (Maxwell and Walley, 2003; Likic and Maxwell, 2009), tested on their practical application (Langford et. al., 2004) and prescribers are kept up to date. There has been little evidence however about the effectiveness of undergraduate education in reducing prescribing errors after qualification. There is some evidence that students cope better with objective structured clinical examinations of prescribing skills over time (Langford et. al., 2001).

Mistakes resulting from applying bad rules or misapplying or failing to apply good rules (rule-based mistakes), can be prevented by improving rules. Training can help in preventing technical ‘slips’ (action-based) errors. Memory-based errors are the most difficult to prevent. They are best tackled by putting in place systems that detect such errors and allow remedial actions. Check list and computerized systems can help (Aronson, 2009).

Dean et. al. (2002a) carried out a study to determine the causes of prescribing errors in hospitalized patients in which 88 potentially serious errors were reported. The results, which were presented according to Reason’s four stages of human error (page 17), identified an active failure in every instance. Of these, skill-based slips or lapses

were most frequent. Although all the prescribers making the slips and lapses were unable to explain the reasons for this, mention was made of interruption during routine tasks or busyness. Slips were found to be more frequent than lapses (23 versus two).

In addition, the researchers noted that all mistakes made were rule-based. A common cause was the absence of knowledge for a relevant rule such as how to reduce a dose of drug in renal failure. Two violations were reported both of which involved doctors not adequately checking the dose of prescriptions written by final year medical students despite being aware of the hospital policy that requires that the entire prescription should be checked.

Error producing conditions noted by the researchers involved the interaction between the workload and staffing. Doctors cited multiple factors as having contributed to their error, the most frequent concerned the work environment such as heavy workload, staffing and physical environment; individual factors, and the working of the team. Staffing issues mentioned included inadequate staffing, effects of new or locum staff, and attending to another doctor's patient. Personal factors mentioned in relation to prescribing errors included physical and mental well-being: such as tiredness, hunger, ill-health; skills and knowledge. Team factors reported to affect risk of prescribing errors include absence of or poor communication within and between teams, inadequate supervision and overlapping responsibilities between teams.

The most revealing latent condition was that many doctors did not seem to consider the task of prescribing drugs as important. The researchers noted that the act of prescribing was often embodied in a drug name and the details of dose, form, frequency, route, duration and so on are left to the junior doctors to complete. This lends support to findings by other researchers that dosage errors are usually the most common and potentially serious prescribing errors noted (Seden et. al., 2013).

In the study by Dean and colleagues, pharmacists were identified as the main source of defence by the doctors interviewed. Doctors welcomed help from pharmacists, since they not only identified mistakes but also provided an educational role in doing so. Nurses and midwives were also mentioned as being part of the defences.

Although the study depended on the account given by the people who had made the mistake, and therefore causality cannot be ascribed with certainty, it does gives some insight into the causes of prescription errors in hospitals. An in-depth consideration of the highlighted factors makes it certain that prescribing errors can be reduced by training, adherence to existing systems of work and through the introduction of new working practices (Barber et. al., 2003). Similarly prescribing can be improved by bringing the details of prescribing into the open, by reviewing errors in prescribing so that prescribers learn and patients benefit (Dean, 2002).

Developing effective ways to reduce error is dependent upon identifying and understanding their causes and the factors associated with them. Identifying the cause of an error is linked with knowing the intention of the person who committed it (Dornan et. al., 2009). The action performed may have been different to that originally intended or may have been that intended but actually wrong. For example, not decreasing a dose in renal failure because of lack of knowledge that it was necessary.

2.8 Factors that modify the risk of errors

The overall safety of a system depends on checking for errors during the process. However in practice, this has not always been effective (Patterson et. al., 2007). This intrinsic risk can be modified by other factors which in the context of medication errors include: factors relating to the person performing the action; the circumstances in which the action is performed, the state of the patient; and particular characteristics of the medicine.

2.8.1 The person performing the action

Some people are more likely to err than others for 'constitutive' reasons such as their intrinsic thoroughness, hesitancy or perfectionism (McManus and Vincent, 1993). Overlaid on this 'differential accident involvement' are other factors that can increase or reduce the likelihood of error. In a large prospective Australian study of anaesthetists, one or more of the following factors were thought to be present when medication errors occurred: inattention (37.0% of medication errors); haste (39.0%); distraction (27.0%) and fatigue (11.0%) (Abeysekera et. al., 2005).

Junior doctors are reported as making more errors (Fijn et. al., 2002; Hendey et. al., 2005 and Stubbs et. al., 2006). In a prospective study of prescribing errors in an eye hospital, medicine-related errors were identified in 15/1808, all made by junior doctors and none by senior doctors. Conversely, in another study, senior doctors made just as many errors as junior doctors in writing prescriptions (Mandal and Fraser, 2005). The mental state of the prescriber might influence susceptibility to error (Dean et. al., 2002b; Coombes et. al., 2008). In a questionnaire study of 123 paediatric residents, the 17 who were depressed were six times as likely to prescribe making a medication error as those who were not (Fahrenkopt, 2001).

2.8.2 Site

The risk of harm from medications in hospitals depends on the type of wards. Bates and colleagues (1995) reported that error rates (expressed as adverse events per 1000 patient-days per drugs used, were twice as high on medical intensive care units as on surgical ones. Several other studies have shown high rates of medication errors in intensive care units (Calabrese et. al., 2001; Kopp et. al., 2006). Part of the explanation may lie in the higher rate of prescribing errors in critical care units, where the prescriber may not have access to critical information such as drug allergies, drug-drug interactions, or concomitant medical conditions. In a 6-month prospective analysis of medication order errors in a large Israeli hospital, the surgical ward had the highest number of errors, followed by internal medicine (Lustig, 2000). Prescribing errors in out-patients seem less common, 7.6% in one study (Ghandi et. al., 2005).

2.8.3 Working conditions

Taxis and Barber (2003) identified several error-producing conditions associated with intravenous medication errors. Lack of knowledge of the preparation procedure and inadequate use of technology were the most common failures. The authors also highlighted the role of the technology- poorly designed equipment or unsuitable preparation procedures- in producing errors, and lack of appropriate training and failure to involve pharmacists as important latent conditions. Nichols and colleagues (2008) carried out face-to-face interviews with 26 medical staff members who had been involved in a medication error. There were 21 slips or lapses, and eight knowledge-based mistakes. The healthcare professionals responded that slips or

lapses were most likely to occur when they were busy, tired or distracted. Several other studies have reported an increased incidence of errors due to stress (Sexton et. al., 2000; Reilley et. al., 2002), fatigue (Gander et. al., 2000; Sexton et. al., 2000; Coombes et. al., 2008) and heavy workload (Dean et. al., 2002a; Seki and Yamazaki, 2006).

2.8.4 The patient

A meta-analysis showed that the proportion of admissions to hospitals with adverse drug reactions that were preventable was much higher in elderly than in younger adults (Beijer and de Blaey, 2002). In a review of medical records from hospitals in two American states, there was a significantly higher incidence of preventable drug-related adverse events in patients aged over 64 than in patients aged 16-64 years i.e. 5.0% versus 3.0% (Thomas and Brennan, 2000).

Errors are also significantly more likely in children. Kaushai and colleagues (2001) in an in-patient study using a prospective chart review showed that the rate of 'near-miss' errors in children was three times the rate in adult patients. Furthermore, prescribing for patients with acute or complex clinical diseases or had language difficulties were reported as being more likely to result in errors (Dean et. al., 2002a; Coombes et. al., 2008).

2.8.5 The medication

In a retrospective review of medication errors, reported over a 4-year period in a large paediatric hospital, Ross et. al. (2000) found antibiotics were the commonest drugs and the intravenous route was the commonest route involved in errors. A large 9-year study of prescribing errors in a teaching hospital (Lesar et. al., 1997) identified the three drug classes commonly involved in prescription errors as antimicrobials (34.0%), cardiovascular agents (16.0%) and gastrointestinal agents (7.0%). Similarly a prospective study by Ghandi et. al. (2005) identified anti-infective drugs accounting for most errors. In a recent study involving seven Lebanese hospitals, antiulcer agents, antibiotics, NSAIDs and steroidal agents were the medications mainly involved in prescribing errors (Al-Hajje et. al., 2012).

2.8.6 Computer assistance

The impact of computer physician order entry on medication errors in a paediatric critical care unit was studied by Potts et. al. (2004). They reported that the rate of medication prescribing errors fell significantly from 30 per 100 orders to 0.2 per 100 errors. The rates of adverse drug events and rule violations also fell significantly. In a prospective study in three units, of which two used paper-based prescribing and one computer based prescribing, minor medication prescribing errors were significantly lower in the computer-based unit (0.7 per 100 orders) than in the paper based units (18 per 100 orders). Serious prescribing errors were also significantly less common in the computer based unit. However the authors reported that the computer system introduced two new types of errors: double prescriptions and insufficient drug monitoring information (Colpaert et. al., 2006).

In the UK, where hospital prescribing is paper-based, introduction of a computer-based prescribing system halved prescribing errors on a surgical ward (Donyai et. al., 2007). In a separate study, based on an intensive care unit, error rates fell from 6.5 to 4.8%, mainly because of the reduction in errors of omission, although the computer system was responsible for at least one important error related to a drop-down menu. This occurred when the operator had to perform cognitive tasks (Shulman et. al., 2005). Thus while computers can effectively reduce the rate of easily counted errors, they appear to introduce other kinds of errors. More research is indicated in its use in the medication process.

2.9 Types of studies

Studies on medication errors and adverse events have used different approaches, and each has its strengths and limitations. These studies may be classified according to whether they focus on outcome or process and whether the study designs are retrospective or prospective (Franklin et. al., 2005).

2.9.1 Outcome- based studies

Outcome- based studies stand on identifying actual patient harm. Studies in this category are designed to study all types of iatrogenic injury or all types of adverse drug events and not just prescribing errors in particular. However, depending on how the data are presented and analysed, it is possible to determine the occurrence of

prescribing error-related events. Data collection can be either retrospective or prospective.

2.9.2 Process-based studies

Process-based studies are founded on the prescribing process. These involve health-care professionals, usually pharmacists, reviewing prescriptions to identify prescribing errors. Although they may be retrospective or prospective in design, most are prospective. Prospective studies have substantial advantages in epidemiological research since they can, in principle ensure that the required information is collected, reduce bias and allow complete ascertainment (Ferner, 2009).

Pharmacists prospectively identify prescribing errors, draw these to the attention of the prescriber who will often correct the medication order before the patient receives any medication or before many doses have been received. There are therefore few actual adverse outcomes.

The examination of medical records has been widely used (Oshikoya and Ojo, 2007; Condren et. al., 2010; Sanguansak et. al., 2012; Seden et. al., 2013). A more complete understanding of medication errors and the harm they cause can come from reviewing a wide range of information: hospital discharge summaries, procedure notes, physician progress notes, laboratory reports, physician orders and nursing/multidisciplinary progress notes were suggested in one US study (Morinoto et. al., 2004). The existence of several sources helps to compensate for the incompleteness of each source.

2.10 Interventions to influence health professional behaviour

There have been many ways developed to influence or improve how health care professionals care for their patients in literature. When trying to change how health care professionals prescribe medications, methods such as audit and feedback, educational outreach visits (EOVs) have been reported to be effective and most consistently showed positive results (Ostini et. al., 2009).

2.10.1 Educational outreach visits (EOV)

Trained people visit clinicians where they practice and provide them with information to change how they practice. This information may include feedback about their

performance, or may be based on overcoming obstacles to change. This type of face-to-face visit has also been referred to as university-based educational detailing, academic detailing and educational visiting. In a review of studies that evaluated educational outreach visits, Arnold and Straus (2005) and O'Brien et. al. (2007) reported that outreach visits consistently provided small changes in prescribing which might be potentially important when hundreds of patients are affected. They concluded that multifaceted interventions incorporating EOV are generally effective in improving appropriate care and prescribing when compared to no intervention, but more mixed effects were observed for educational outreach as a single intervention. Specific combinations of multifaceted approaches within which educational outreach was found to be effective included social marketing, audit and feedback, reminders, educational materials and conferences (Campino et. al., 2009; Thomas et. al., 2008).

By contrast, other investigators found that, even in multifaceted interventions, EOV did not improve prescribing. Baucher et. al. (2006) used a model of EOV with opinion leaders conducting the outreach. This intervention unsuccessfully improved already good prescribing behavior. Naughton et. al. (2007) reported that there was no advantage in providing educational outreach in addition to a mailed audit and feedback process. An EOV study by Pit et. al. (2007) produced modest short-term effects. In all the studies of multi-faceted interventions, it is impossible to separate out the contributions made by individual types of intervention.

For other types of professional practice, such as providing screening tests, EOV provide small to moderate improvements.

2.10.2 Audit and feedback

In an audit and feedback process, an individual's professional practice or performance is measured and then compared to professional standards or targets. In other words, their professional performance is 'audited'. The results of this comparison are then fed back to the individual. The aim is to encourage the individual to follow professional standards.

Though often used in healthcare organizations to improve health professionals' performance, audit and feedback is often used together with other interventions such as educational meetings or reminders. Franklin et. al. (2007) in a pilot study

undertaken in a London Teaching hospital, provided feedback to doctors about prescribing errors at the levels of consultant team, and clinical specialty. The feedback report, which consisted of graphical summaries, a list of errors identified for the team concerned and commentary was found to be helpful and acceptable by the concerned clinical specialty with most doctors asking to receive similar reports routinely. Though their study did not consider whether providing feedback in this way led to a measureable reduction in prescribing errors, other researchers have reported its effectiveness in reducing inappropriate prescribing by doctors (Herbert et. al., 2004; Awad et. al., 2006; van der Elst et. al., 2006; Horn et. al., 2007; Finkelstein et. al., 2008).

A high quality review on the effectiveness of audit and feedback (Davey et. al., 2005) suggested that audit and feedback were effective in improving appropriate care overall. Grindrod et. al. (2006) found audit and feedback effective and reported that a meta-analysis of five studies found peer comparison audit and feedback had a modest effect on physician's use of clinical procedures and that audit and feedback was an effective method for improving immunization rates. In contrast, Jamtvedt et. al. (2006) found audit and feedback to vary in effect, from a negative to a large positive effect, specifically for prescribing outcomes. They suggested that audit and feedback were most effective when baseline compliance with recommendations was low.

A review conducted by researchers in The Cochrane Collaboration (Ivers et. al., 2012) showed that the effect of audit and feedback on professional behavior and on patient outcomes ranged from little to a substantial effect. Audit and feedback may be most effective when baseline performance is low, the source of the audit and feedback is a supervisor or colleague, it is provided more than once, it is delivered in both verbal and written formats, and when it includes both explicit targets and an action plan. In addition, the size of effect varied based on the clinical behavior targeted by the intervention.

CHAPTER THREE

METHODS

3.1 Study design:

In order to assess the prevalence, nature and types of prescribing errors, a quantitative (descriptive) approach was used. This involved:

1) A retrospective review of randomly selected out-patient prescriptions covering the period between Jan – Dec 2010. The prescriptions were obtained from the pharmacy department and included prescriptions received from the general out-patient, medical and paediatric out –patient (ambulatory) departments of the three hospitals. All prescriptions were hand-written on the hospital's formatted prescription sheets. Data forms were used to collect information such as date of prescription, patient demographic characteristics, prescriber identification (name/signature), number and types of drugs prescribed, number of prescription with errors, type of error, and medications associated with the error.

2) A retrospective review of randomly selected medical records including treatment sheet prescriptions and medical notes of in-patients from specialties such as general medicine, general surgery, psychiatry, dental, urology and paediatrics in the year 2010 was undertaken. These were screened and assessed for prescribing errors that met the study definition. Data collection forms were used to extract the following information: ward type, date of admission and discharge, patient demographic characteristics, prescriber ward round type, prescribing stage, number of items with prescription errors, type of error, medications associated with the error.

The period between January – December 2010 was covered in this study. (See Appendix B for an example of the data collection sheet used).

3.2 Study setting

The study was undertaken in the three tertiary hospitals listed below:

- National Hospital Abuja (NHA) - At this time, a 200-bed tertiary hospital, NHA plays a key role in the provision of health services to the residents of Abuja, a cosmopolitan multi-ethnic, multi-cultural urban city with high socio-economic disparity. Out-patient attendance is approximately 8000 monthly.

- University of Abuja Teaching Hospital (UATH) Gwagwalada- The hospital is located in Gwagwalada Area Council of the Federal Capital Territory. This 350-bed hospital was conceived by Federal Capital Development Authority (FCDA) as a reference hospital for the Federal Capital Territory. Out-patient attendance is approximately 5000 monthly.

- University College Hospital (UCH) Ibadan- This hospital, located in the heart of the bustling historic city of Ibadan, functions within the context of major socio-economic inequities, indigenous populations and serious health challenges. UCH is a 850-bed tertiary teaching hospital. Out-patient attendance is approximately 10,000 monthly.

Tertiary hospitals, apart from providing referral services to the numerous primary and secondary health care facilities within their territories and beyond, also serve as institutions for training of health personnel offering undergraduate, graduate, post-graduate and residency programmes. The medical staff structure in these hospitals include the: (a) House officers comprising the newly qualified doctors on the mandatory one-year internship training. The first experience of unsupervised prescribing by the interns begins during the internship. These foundation year doctors are admitted in two batches of six-months spread (usually May and December) and undergo 3-months clerkship/rotation in the four major clinical specialties (viz internal medicine, surgery, paediatrics and obstetrics / gynaecology); (b) The National Youth Service Corp doctors; (c) The junior and senior Residents; (d) Consultants of various specialties; (e) Visiting Professors and other medical personnel on research activities and sundry. These three tertiary hospitals were chosen for the diversity of the patient

population, the acuity and academic environment provided for training and molding of doctors and other medical/non-medical personnel, the consistency of medication/ pharmacy service and data availability.

These hospitals operate the usual pharmacy service. Briefly, this involved prescribers handwriting medication orders onto formatted (pre-printed) prescription forms for out-patients. These prescription forms were subsequently presented to the pharmacy staff at the pharmacy units serving the clinics. After patients have been served with their prescribed medicines, duplicate copies of the prescription forms were kept in the pharmacy for record keeping and other purposes.

Similarly for the in-patients, prescribers hand write medication orders into the patient's medical notes as well as onto formatted treatment sheets. These orders are taken to the pharmacy units where pharmacists check that the orders are clear, clinically appropriate and valid before initiating the supply of any drugs to patients in the wards. These same documents are used by the nursing staff to determine the doses due at each medication round and to record their administration.

3.3 Error definition and types

Medication prescribing errors have been described as any type of deviation from a complete, accurate and legible prescription, as it pertains to errors on the prescription (Sanguansak et al, 2012). The Nigeria Standard Treatment Guideline (2008), which enumerates the essential features of a prescription, does not give a definition of a prescribing error. However, the error types / classification used in this study were based on this requirement. They are: (1) identity of prescriber: including name and signature; (2) identity of patient: including age and gender; (3) date of the prescription (4) elements specifying the medication such as medication name, strength, dosage, frequency, route, duration, direction for use, and additional labeling instructions; (5) abbreviations: only standard official abbreviations are acceptable. Any deviation from the above specifications was considered a prescribing error and was reported in this study. Additionally, the definition of a prescribing error, developed by Dean et al (2000) was also used in this study. A clinically meaningful prescribing error was defined as *a prescribing decision or prescription writing process that results in an unintentional, significant reduction in the probability of treatment being timely and*

effective or increases the risk of harm when compared with generally accepted practice. This definition embodies errors such as prescribing without taking the patient's clinical status into account, lapses in communicating essential information and transcription errors. See Appendix A for a detailed list of events that constitute a prescribing error.

3.4 Subjects

Inclusion criteria: Prescriptions hand-written by doctors within the study period.

Exclusion criteria: Non-hand written prescriptions; prescriptions originating from non-medical personnel.

3.5 Prescriber category

The prescribers were indicated on the data collection form in the following categories: (1) House officers (newly qualified doctors in internship year); (2) Medical officers, also known as casualty officers, are junior doctors not yet on the residency programme; (3) Registrars (doctors on foundation year residency training); (4) Senior Registrars (mid-grade specialists); (5) Consultants (senior specialists training fellows) and (6) unidentified prescriber (inadequate information to identify prescriber).

3.6 Sample size statement

- Estimate of prevalence = 50% or 0.50 (a conservative estimate since there is no prior published study
- Confidence level = 95%
- Accuracy of ±1.4 percent

The sample size was calculated using the Raosoft Sample size calculator (www.raosoft.com/samplesize.html). The sample size obtained was rounded up to the nearest 100 (i.e. 400) to give a uniform number for all three sites.

Four hundred patients' records would allow estimation of the prevalence of prescribing errors to within 1.4 percentage points either side of the estimated prevalence using a 95% confidence interval, assuming that the prevalence is approximately 50%.

3.7 Grading of errors

The error severity classification scheme grading, developed by some researchers (Dornan et. al., 2009) was used as a guide to clinical significance (Appendix C). For the purposes of this evaluation "potentially lethal, serious and significant" errors were grouped as 'serious' and "minor" as 'non-serious'. Serious and non-serious prescribing error rates were calculated. [Similar errors were grouped together and classified as either "serious" or non-serious" by this researcher; the project supervisors reviewed these classifications independently. Any disagreements were resolved together].

3.8 Data management and analysis plan

Data collected was stored using Microsoft Office Excel 2007 and analysed using the Statistical Package for the Social Sciences (SPSS) software version 17 (SPSS Inc. Chicago, Ill, USA). Nominal variables were analyzed using descriptive statistics which consisted of frequency distribution and percentages.

The outcome of primary interest was the percentage prescribing error rate per hospital, clinical significance and stage of patient stay. Secondary outcome was the mean rate of prescribing errors across the grades of prescribers.

Chi-squared statistics was used to test the associations. Values of $p < 0.05$ for a two-sided test (paired sample t-test) was considered as statistically significant.

Part 2: Exploring the causes of prescribing errors

In assessing the factors involved in and causes of prescribing errors, a qualitative approach was used.

The doctors in the selected specialties and wards were informed about the study and the goal was explained to them. On selected 5-days a month, between the months of July and December 2011, the researcher prospectively reviewed medications ordered for in-patients in the medical, paediatric and private wings of the National hospital Abuja. Prescribing errors that met the study definition were identified. The prescriber involved in the event was invited for interview.

3.9 Interview schedule

The purpose of the interview was to explore the prescribers' experiences of prescribing errors, their opinions on the reasons for these errors, the situation in which it was made, their attitude towards it and the relationship that these errors had to the medical teaching/experience that they received. Participants were provided with a choice of where, within the hospital complex, the interviews were to be conducted. Only prescribers who were involved in error incidents and contactable within 72 hours of the incident were interviewed to ensure adequate recall. Semi-structured face-to-face interviews, incorporating a questionnaire, were conducted to determine the causes of prescribing errors. The questionnaires investigated the relative contribution of various factors in error production. Causes were defined as 'reasons reported to the researchers by the prescriber as being wholly or partially responsible for a specific prescribing error'. The interview was applied to the prescribers in NHA only. Interviews took between 15 and 25 minutes. The process was adapted from the methods of other researchers (Dean et. al., 2002; Coombes et. al., 2008, Dornan et. al., 2009). Appendix D outlined the process.

3.9.1 Definitions

Active failures are the unsafe acts committed by the prescribers in contact with the patient. All errors therefore, would be expected to be as a result of at least one active failure. Memory lapses are errors due to omission of a particular task and slips are errors due to attention failure when performing a task or an active failure resulting from the incorrect execution of a task. Mistakes were errors occurring from correct execution of an incorrect or inappropriate plan and were either rule-based (RBM) or knowledge-based mistakes (KBM).

Error-producing conditions are related to the task and the environment at the time when the error occurred. They may not directly cause errors, but are underlying risk factors and can be grouped as connected to the individual prescriber, the working condition, the healthcare team, the prescribing task and patient. Latent conditions are organizational processes that create an environment where error-producing conditions and active-failures are more likely to result in prescribing errors.

Violations are active choices by prescribers to ignore the formal or informal policies or guidelines they are expected to adhere to. Defences are designed to protect against hazards and mitigate consequences of failure.

3.9.2 Analysis of data

Notes taken during the interviews were transcribed afterwards and reviewed by the interviewers (a consultant physician and the researcher). Common themes relating to the reporting of errors were identified and coded manually based on the interviewees' words and phrases. Consensus was reached through discussion. The result was presented according to Reason's four stage model of human error (Figure 2.1, see page 15).

3.10 The Intervention

Following the outcome of the qualitative prospective study based on the causes of prescribing errors identified from the prescribers, interventions involving educational outreach encompassing structured teaching / training and feedback sessions was undertaken with the prescribers. Apart from the opportunity for one-on-one education/discussion provided by the face-to-face interviews, feedback presentations of the prescribing errors identified from the previous 6-month study was undertaken at different times, from January to March 2012. The presentations were made to the doctors as follows: (1) Department of Family Medicine. (2) Department of Medicine. (3) Department of Paediatrics.

The feedback report consisted of power-point graphical presentations of prescribing error summaries, list of types and examples of errors identified from the concerned specialties, medications involved, teaching on the principles of writing a proper prescription and commentaries on responsibility and adequate supervision.

This provided opportunity for interaction and education with the prescribers in small groups, at the departmental level. All cadres of prescribers were present for the feedback sessions viz Consultants, Senior Registrars, Registrars, Medical officers, House officers. Other professionals such as Nurses and Pharmacists were also present.

Subsequently, post-intervention data collection was undertaken for another six months, from May till October 2012. Prescription errors that met the study definition

were collected on five selected days of each month. Error rates and types before and after the intervention were compared and analysed to determine the impact of the intervention.

The intervention was applied to the prescribers in NHA while the other sites, UCH and UATH acted as the control.

The Ethics committee of the hospitals gave approval for the study.

3.11 Impact evaluation analysis

Prescriptions from both intervention and control groups were assessed after the intervention, as in the baseline survey. Data were analyzed using the SPSS software: Chi - squared test to assess differences in means for pre- and post- intervention values and a confidence interval (CI). Statistical significance was placed as a p-value <0.05.

CHAPTER FOUR

RESULTS

4.1 General Outpatient department

There were more prescriptions generated from the NHA (N= 3662) than from the UCH (N= 3313) and UATH (N= 1295) for the study period. Of the NHA prescriptions, 1947 (53.1%) were females with a majority 2377 (65.0%) being adult patients. However, the gender of 36 (1.0%) of these patients could not be determined as this information was omitted on the prescription sheets (Table 4.1). Similarly, out of the 1295 patient prescriptions assessed from the UATH, there were more females 604 (46.6%) and more adults 677 (52.3%) while, the gender of about 132 (10.2%) and ages of 111 (8.6%) of these patients could not be determined. Omitted patient information (sex and age) was higher from prescriptions generated from UATH 132 (10.2%) and 111 (8.6%) than from those from NHA 36 (1.0%) and 86 (2.3%) respectively. No information on patients' gender could be obtained from the UCH out-patient prescription sheets, however there were more adult patients 2153 (65.0%) though the ages of 788 (23.8%) of the population could not be determined.

4.1.1 Prescribing error rates per hospital site

Out of the 10,608 medication orders evaluated from the NHA, 604 prescribing errors were detected giving a mean error rate of 5.7% across all grades of prescribers while an error rate of 6.7% was determined for UCH prescribers. Conversely a higher mean prescribing error rate of 24.6% was determined for prescribers at the UATH where 3535 medication orders screened yielded 868 prescribing errors. This gave approximately a four-fold increase when compared with the other institutions.

The prescribing error rates of the three hospitals are shown in Table 4.2.

Table 4.1: Demographic characteristics of the study population

	UATH N=1295 (%)		NHA N= 3662 (%)		UCH N = 3313 (%)	
Gender						
Males	559	(43.2)	1679	(45.9)	Nil*	
Females	604	(46.6)	1947	(53.1)	Nil*	
Sex not indicated	132	(10.2)	36	(1.0)	3313	
Age						
Child <18yrs	507	(39.1)	1199	(32.7)	372	(11.2)
Adult >18yrs	677	(52.3)	2377	(65.0)	2153	(65.0)
Age not indicated	111	(8.6)	86	(2.3)	788	(23.8)

UATH = University of Abuja Teaching Hospital; NHA = National Hospital Abuja; UCH = University College Hospital

***UCH Out-patient prescription sheets do not have entries for patients' sex

Table 4.2: Prescribing error rates of out-patient prescriptions per hospital

	UATH	NHA	UCH
Number of medication orders that were checked	3535	10,608	9786
Number of errors detected	868	604	658
Mean error rate per 100 medication orders	24.55	5.69	6.72
Mean rate of prescribing errors across all grades of prescriber	24.6%	5.7%	6.7%

UATH = University of Abuja Teaching Hospital; NHA = National Hospital Abuja; UCH = University College Hospital

4.1.2 Types of prescribing errors

Incomplete prescribing information or omission errors were the commonest prescribing errors in the out-patient prescriptions from these hospitals. Omitting to write the direction for use of medications 331 (38.1%) was commonest at the UATH, omission of prescribers' identity 402 (66.6%) was commonest at NHA while omitting to give a stop date or duration of therapy of medicines 358 (54.4%) was the commonest prescribing error by the UCH prescribers (Table 4.3).

Prescribing error types common to the three hospitals were prescribers omitting to write their names and/or signatures, omitting to give complete patient information, omitting to indicate the direction of use of medicines prescribed, dosing problems such as omitting to write the dose or strength of medicines and problems of under and overdose), unsafe abbreviations and omitting to include the duration of use of prescribed medicines.

4.1.3 Medications associated with prescribing errors

4.1.3.1 National Hospital Abuja

Oral preparations for fluid and electrolyte imbalance (ORS), was the class most commonly associated with errors 30 (30.0%), followed by the antibacterials 9 (9.0%) and analgesics 9 (9.0%). Table 4.4 (a) gives a breakdown of the various medication classes identified.

4.1.3.2 University of Abuja Teaching Hospital

Similarly, oral preparations for fluid and electrolyte imbalance (ORS), was the class most commonly associated with errors 173 (34.9%). This was followed by the antibacterials 130 (26.2%), antimalarials 68 (13.7%) and the cardiovascular system drugs, 40 (8.1%).

Table 4.4 (b) gives a breakdown of the various therapeutic classes identified.

Table 4.3: Types and prevalence of prescribing errors identified from out-patient prescriptions.

ERROR DESCRIPTION	UATH N	%	NHA N	%	UCH N	%
Incomplete information						
Prescriber name/signature omitted	76	8.8	402	66.6	102	15.5
Patient's details (age/sex) omitted	195	22.5	107	17.7	(658)*	
Direction for use omitted	331	38.1	67	11.1	125	19.0
Dose/strength of medicine omitted	65	7.5	10	1.6	20	3.0
Duration/stop date of medicines omitted	147	16.9	1	0.2	358	54.4
Drug name omitted	1	0.1	1	0.2	0	0
Route of administration omitted	5	0.6	0	0	1	0.15
Frequency of administration omitted/incorrect	4	0.5	3	0.5	0	0
Dosing						
Dose Inappropriate (Under dose)	23	2.6	2	0.3	19	2.9
Dose Inappropriate (Overdose)	1	0.1	5	0.8	4	0.6
Interaction						
Serious drug interaction	0	0	0	0	2	0.3
Abbreviation						
Unsafe Abbreviation	20	2.3	3	0.5	22	3.3
Others						
Therapeutic duplication	0	0	2	0.3	3	0.5
Wrong patient	0	0	1	0.2	0	0
Extended duration	0	0	0	0	1	0.15
Dosage form not specified	0	0	0	0	1	0.15
Total	**868**	**100**	**604**	**100**	**658**	**100**

***While** whiteout-patient prescription sheets used in UCH during this study period did not have entry of patient sex and age, there was provision for patient age in the blue prescription sheets (See Appendix F).

Table 4.4 (a): Types of medications associated with errors in National Hospital Abuja.

S/No	Therapeutic class*	Number	(%)
1.	Fluids & Electrolyte imbalance (ORS)	30	30
2.	Antibacterial drugs (oral & parenteral)	9	9
3.	Analgesics (non-opoid)	9	9
4.	Antimalarials (oral & parenteral)	5	5
5.	Antibacterial skin preperations	5	5
6.	Antifungal skin preparations	4	4
7.	Antihistamines & allergic emergencies	3	3
8.	Antiseptic & skin cleanser	3	3
9.	Hypertension & Heart failure (CVS)	2	2
10.	Vitamins	2	2
11.	Anti-infective eye drops	2	2
12.	Topical corticosteroid	2	2
13.	Corticosteroid + other anti-inflammatory inhalers	2	2
14.	Emollient & barrier preparation	2	2
15.	Cough remedies	1	1
16.	Medicines used in diabetes	1	1
17.	Haematinics	1	1
18.	Minerals	1	1
19.	Anti-inflammatory eye drops	1	1
20.	Misc. ophthalmic preparations	1	1
21.	Anti-pruritics	1	1
22.	Haemorrhoidal preparations	1	1

S/No	Therapeutic class*	Number	(%)
23.	Drugs acting on the nose	1	1
24.	Alkalinisation of urine + mild UTIs	1	1
25.	Sympathomimetics	1	1
26.	Laxatives (stimulants)	1	1
27.	Shampoos (prep for scalp and hair conditions)	1	1
28.	Lozenges	1	1
29.	Mouthwashes and gargles	1	1
30.	Topical preparation for acne	1	1
31.	Topical NSAID	1	1
32.	Miscellaneous	3	3
	Total	**100**	**100.0**

*The classification above was based on the British National Formulary (BNF) categorization: ORS= Oral re-dehydration salts; CVS= Cardiovascular system; UTIs= Urinary tract infections; NSAID= Non steroidal anti-inflammatory drug.

Table 4.4 (b): Types of medications associated with errors in University of Abuja Teaching Hospital

S/No	Therapeutic class*	Number	(%)
1.	Fluids & Electrolyte imbalance (ORS)	173	34.9
2.	Antibacterial drugs	130	26.2
3.	Antimalarials (oral & parenteral)	68	13.7
4.	Cardiovascular system (Hypertension & Heart failure)	40	8.1
5.	Vitamins	10	2.0
6.	Bronchodilators	9	1.8
7.	Antiepileptics (oral & parenteral)	8	1.6
8.	Oxytocics (oral & parenteral)	7	1.4
9.	Anti-inflammatory eye drops	6	1.2
10.	Anti-fungal preparations (vaginal, vulva and skin)	5	1.0
11.	Analgesics (non-opoid) oral & parenteral	4	0.8
12.	Corticosteroids (oral & parenteral)	4	0.8
13.	Anaemias& other blood disorders	4	0.8
14.	Analgesics (opoid)	3	0.6
15.	Topical NSAIDs	3	0.6
16.	Nausea & vertigo	3	0.6
17.	Drugs used in diabetes	3	0.6
18.	Anxiolytics	2	0.4
19.	Allergic emergencies	2	0.4
20.	Skin cleansers & Antiseptics	2	0.4
21.	Local Anaesthesia	2	0.4
22.	Antihistamines	2	0.4
23.	Anthelmintics	2	0.4

S/No	Therapeutic class*	Number	(%)
24.	Anti-infective skin preparations	1	0.2
25.	Ophthalmic preparations	1	0.2
26.	Anti-infective eye drop / ointment	1	0.2
27.	Dyspepsia and gastro-oesophageal reflux disease	1	0.2
	TOTAL	**496**	**100.0**

*The classification above was based on the British National Formulary (BNF) categorization.

4.1.3.3 University College Hospital

The Cardiovascular system (drugs for hypertension & heart failure) was the drug class most commonly associated with errors 59 (10.6%), followed by the anti-inflammatory and anti-allergic eye drops 58 (10.4%) and diuretics (9.9%). Table 4.4 (c) gives a breakdown of the various medication classes identified.

4.2: Types and prevalence of prescribing errors in In-patients

4.2.1 Demographic characteristics of patients whose medical records were assessed

4.2.1.1 Age

Age of patients ranged from below one month to over 65 years. Majority of the patients fell within the 15 -65 years age range across the three hospitals (Table 4.5).

4.2.1.2 Sex

There were more male patients at the UATH and NHA while at the UCH female patients were more (Table 4.5).

4.2.2 Proportion of medicines prescribed per physician

Of the 5220 medicines prescribed for the UATH in-patients, 2991 (57.3%) were ordered at the point of admission, while 1482 (28.4%) were ordered during the ward stay and 747 (14.3%) made at the time of discharge. The total number of medication orders generated in UATH was the least of the 3 hospitals while the UCH had the highest number of medication orders (Table 4.6).

In all 3 hospitals, the highest proportion of prescriptions was ordered at the point of admission while the point of discharge had the lowest proportion of prescribed medicines.

4.2.3 In-patient prescribing error rates

A total of 1496, 1681 and 2776 prescribing errors were determined from the medication orders written by prescribers at the UATH, NHA and UCH respectively. This gave a prescribing error rate of 28.7%, 26.3% and 41.0% respectively (Table 4.7).

4.2.4 Types and prevalence of in-patient prescribing errors

The commonest type of prescribing error determined in all three hospitals was incomplete prescription information. Particularly common was omission of duration/stop date of prescribed medicines. This was highest at the UCH 2386 (86.0%), followed by UATH 1066 (71.3%) and NHA 1108 (65.9%). Dosage errors such as under and over doses ranked next and this was followed by the use of unsafe abbreviations. Prescribing medicines that could result in serious interactions was also recorded in all three hospitals (Table 4.8).

See Appendix E for examples of the types of prescribing errors encountered.

4.2.5 Clinical severity of the errors

4.2.5.1 University of Abuja Teaching Hospital

It was determined that 255 (17.0%) of the prescription errors were potentially serious, equivalent to 4.9% of all medication orders written (Table 4.9a). The time of discharge was associated with the highest proportion of prescribing errors, while the least errors were during the in-patient stay.

Examples of potentially serious and less serious errors are given in Table 4.9b. Some of the potentially serious errors would be expected to have resulted in some patient harm if they were not intercepted.

Table 4.4 (c): Types of medications associated with errors (UCH)

	Therapeutic class*	Number	(%)
1.	Cardiovascular system (Hypertension & Heart failure)	59	10.6
2.	Anti-inflammatory & anti-allergic eye drops	58	10.4
3.	Diuretics	55	9.9
4.	Anti-infective eye drop / ointment	48	8.6
5.	Misc. ophthalmic preparations	42	7.6
6.	Anti-bacterials (oral & parenteral)	36	6.5
7.	Drugs used in diabetes (Insulin& OAAs)	29	5.2
8.	Antipsychotics	25	4.5
9.	Antiplatelets	24	4.3
10.	Treatment of glaucoma	24	4.3
11.	Fluids & Electrolyte imbalance (ORS)	23	4.1
12.	Vitamins	23	4.1
13.	Topical NSAIDs	11	2.0
14.	Laxatives	9	1.6
15.	Analgesics (non-opioid)	9	1.6
16.	Anti-malarias	8	1.4
17.	Lipid regulating drugs	7	1.3
18.	Anti-fungal skin preparations	7	1.3
19.	Haematinics	6	1.1
20.	Antidepressants	6	1.1
21.	Anxiolytics	5	0.9
22.	Anti-convulsants	5	0.9
23.	Topical corticosteroids & other anti-inflammatory agents	5	0.9
24.	Corticosteroids (oral & parenteral)	5	0.9

	Therapeutic class*	Number	Percentage (%)
25.	Medicines for malignant diseases	4	0.7
26.	Medicines acting on ear / nose	3	0.5
27.	Minerals	3	0.5
28.	Anti-infective skin preparations	3	0.5
29.	Analgesics (opioid)	3	0.5
30.	Antihistamines	2	0.4
31.	Anthelmintics	1	0.2
32.	Local anaesthetics	1	0.2
33.	Thyroid and anti-thyroid medicines	1	0.2
34.	Antivirals (HIV)	1	0.2
35.	Topical preparation for acne	1	0.2
36.	Cough remedies	1	0.2
37.	Bronchodilators	1	0.2
38.	Miscellaneous drugs	2	0.4
	TOTAL	**556**	**100.0**

*The classification above was based on the British National Formulary (BNF) categorization. OAA= Oral anti-diabetic agents; ORS= Oral redehydration salts; NSAIDs= Non-steroidal anti-inflammatory agents.

Table 4.5: Demographic characteristics of the study population

	UATH		NHA		UCH	
	N	%	N	%	N	%
Age						
Not indicated	1	0.3	3	0.8	3	0.8
< 5yrs	157	39.3	124	31	0	0.0
6- 14 yrs	41	10.3	25	6.3	5	1.3
15-65 yrs	179	44.8	217	54.3	309	77.3
>65 yrs	22	5.5	31	7.8	83	20.8
Total	400	100	400	100	400	100
Sex						
Females	177	44.3	167	41.8	306	76.5
Males	223	55.7	233	58.2	94	23.5
Total	400	100	400	100	400	100

UATH = University of Abuja Teaching Hospital; NHA = National Hospital Abuja; UCH = University College Hospital

Table 4.6: Proportion of in-patient prescriptions written per point of care

Point of care	UATH N	%	NHA N	%	UCH N	%
Admission	2991	57.3	2825	44.3	2891	42.7
Ward Stay	1482	28.4	2671	41.8	2769	40.9
Discharge	747	14.3	888	13.9	1104	16.3
Total	5220	100.0	6384	100.0	6764	100.0

UATH = University of Abuja Teaching Hospital; NHA = National Hospital Abuja; UCH = University College Hospital

Table 4.7: In-patient prescribing error rate per hospital

	UATH	NHA	UCH
Number of medication orders checked	5220	6384	6764
Number of prescribing errors evaluated	1496	1681	2776
Mean error rate per 100 medication orders	28.66	26.33	41.04
Mean rate of errors across all grades of prescribers	28.7%	26.3%	41.0%

UATH = University of Abuja Teaching Hospital; NHA = National Hospital Abuja; UCH = University College Hospital

Table 4.8: Types and prevalence of in-patient prescribing errors per hospital

ERROR DESCRIPTION	UATH N	%	NHA N	%	UCH N	%
Incomplete information						
Duration/stop date omitted	1066	71.3	1108	65.9	2386	86.0
Dose/Frequency omitted	76	5.1	185	11.0	81	2.9
Direction for use omitted	58	3.9	70	4.2	13	0.5
Route of administration omitted	14	0.9	37	2.2	7	0.3
Drug Name omitted	5	0.3	14	0.8	13	0.5
Dosing						
Dose Inappropriate (Under)	145	9.7	116	6.9	20	0.7
Dose Inappropriate (Over)	27	1.8	31	1.8	9	0.3
Dose adjustment in renal/liver impairment	0	0	0	0	7	0.3
Drug / drug interaction						
Serious drug interaction	2	0.1	8	0.5	32	1.2
Ambiguous						
Ambiguous orders	25	1.7	47	2.8	85	3.1
Abbreviation						
Unsafe Abbreviation	70	4.7	48	2.9	115	4.1

ERROR DESCRIPTION	UATH N	%	NHA N	%	UCH N	%
Others						
Wrong formulation	5	0.3	7	0.4	1	0.0
Wrong name	1	0.1	0	0	3	0.1
Therapeutic duplication	0	0	5	0.3	2	0.1
Wrong route of administration	1	0.1	1	0.1	2	0.1
Transcription error	0	0	2	0.1	0	0
Extended duration	1	0.1	1	0.1	0	0
Illegible hand-writing	0	0	1	0.1	0	0
Total	**1496**	**100**	**1681**	**100**	**2776**	**100**

Table 4.9 (a): Prescribing errors according to stage of patient stay, expressed as percentages of the number of orders in University of Abuja Teaching Hospital

Stage of patient stay	No. of medication orders	Serious errors N (%)	Other errors N (%)	Total errors N (%)	95% Confidence Interval Serious errors	Other errors	Total errors
Medication orders written on admission	2991	142 (4.7)	780 (26.1)	922 (30.8)	1.22 to 8.18	22.98 to 29.22	27.82 to 33.78
Medication orders written during remainder of patients' stay	1482	63 (4.2)	229 (15.4)	292 (19.7)	-0.75 to 9.15	10.72 to 20.08	15.14 to 24.26
Medication orders written at discharge	747	50 (6.7)	232 (31.1)	282 (37.7)	-0.23 to 13.63	25.14 to 37.06	32.04 to 43.36
TOTAL	**5220**	**255 (4.9)**	**1241 (23.8)**	**1496 (28.66)**	**2.25 to 7.55**	**21.43 to 26.17**	**26.37 to 30.96**

Table 4.9b: Examples of errors identified in University of Abuja Teaching Hospital

Potentially serious prescribing errors	Less serious prescribing errors
▪ IV Dextrose saline 1L 8hourly prescribed for an elderly hypertensive diabetic patient.	▪ A patient placed on omeprazole 20mg daily was additionally prescribed ranitidine 150 mg twice daily, a therapeutic duplication
▪ Serious drug interaction occurring from co-prescribing Artemether/Lumefantrine tabs and Azithromycin tabs.	▪ A patient was prescribed ferrous sulfate (Fersolate®) 40 mg b.i.d. when frusemide was intended.
▪ IV Amoxicillin+clavulanic acid (Augmentin) 1.2 g prescribed 12 hourly instead of 8hourly in an acute case of infection resulting in sub-therapeutic treatment.	▪ Seretide inhaler was prescribed for a patient without specifying intended dose per inhalation.
▪ IV Ceftriaxone prescribed as 50mg/kg/dose 12 hourly for a child when the intended dose was 50mg/kg/day in 2 divided doses.	▪ Intravenous fluid prescribed with an incomplete name as half strength 500 mL over next 4hours when Half strength Darrows solution was intended.
▪ A patient with anaemic heart failure was prescribed frusemide 40 mg b.d without indicating the route of administration.	▪ Chloramphenicol eye ointment abbreviated as Oc. CPL.

Clinical severity of the errors (continued)

4.2.5.2 National Hospital Abuja

It was determined that 177 (10.5%) of the prescription errors were potentially serious, equivalent to 2.8% of all medication orders written (Table 4.10a). Similarly, the time of discharge was associated with the highest proportion of prescribing errors while the in-patient stay recorded the least errors.

Examples of potentially serious and less serious errors are given in Table 4.10b. Some of the potentially serious errors would be expected to have resulted in some patient harm if they were not intercepted.

4.2.5.3 University College Hospital

It was determined that 87 (3.1%) of the prescription errors were potentially serious, equivalent to 1.3% of all medication orders written (Table 4.11a). Similarly, the time of discharge was associated with the highest proportion of prescribing errors 892 (80.8%) while the in-patient stay recorded the least errors 636 (23.0%).

Examples of potentially serious and less serious errors are given in Table 4.11b. Some of the potentially serious errors would be expected to have resulted in some patient harm except if they had been intercepted.

Table 4.10 (a): **Prescribing errors according to stage of patient stay, expressed as percentages of the number of orders in National Hospital Abuja**

Stage of patient stay	No. of medication orders	Serious errors N (%)	Other errors N (%)	Total errors N (%)	95% Confidence Interval		
					Serious errors	Other errors	Total errors
Medication orders written on admission	2825	66 (2.3)	654 (23.1)	720 (25.5)	-1.32 to 5.92	19.87 to 26.33	22.32 to 28.68
Medication orders written during remainder of patients' stay	2671	72 (2.7)	369 (13.8)	441 (16.5)	-1.04 to 6.44	10.28 to 17.32	13.04 to 19.96
Medication orders written at discharge	888	39 (4.4)	481 (54.2)	520 (58.6)	-2.04 to 10.84	49.75 to 58.65	54.37 to 62.83
TOTAL	**6384**	**177 (2.8)**	**1504 (23.6)**	**1681 (26.3)**	**0.37 to 5.23**	**21.45 to 25.75**	**24.20 to 28.40**

Table 4.10b: Examples of errors identified in National Hospital Abuja

Potentially serious prescribing errors	Less serious prescribing errors
▪ Serious drug interaction occurring from co-prescribing Prednisolone and Ibuprofen and Nifedipine tablets.	▪ An epileptic patient with background acute on chronic kidney disease (CKD) was prescribed phenytoin 200 mg nocte, sodium valporate 400 mg bd without indicating the route of administration.
▪ Poly pharmacy of up to 16 drugs prescribed for a 50yr old CKD patient (CrCl= 8.83mL/min) on dialysis, many of which were above the recommended dose for such a condition.	▪ An order for heamatinics was written for a patient without specifying which was intended.
▪ An order for IV Augmentin® 1.2 g q8hrly was written for a chronic kidney disease patient on dialysis. Recommended maximum dose for amoxicillin is 500 mg daily if CrCL< 10mL/min.	▪ Salbutamol inhaler was prescribed for a patient without specifying intended dose per inhalation
▪ Potassium chloride (Slow K®) tablets 1.200 g bd tablets was prescribed when 1200 mg or 1.2 g was intended.	▪ A patient with resolving haemorrhagic stroke, on discharge was prescribed amlodipine tablets without indicating dose.
▪ A sickle cell patient with vaso-ocular crisis (VOC) was prescribed with sub-therapeutic dose of IM arthemeter (Paluther®).	▪ Lonart DS® tablet prescribed with IM Paluther® without indicating frequency of administration.

4.2.6 Medications associated with errors

Antibacterials and preparations for fluid and electrolyte replacement were associated with the highest proportion of errors in all three hospitals and this occurred most commonly at the point of admission. Medicines for treating hypertension and heart failure and oral antidiabetic medicines ranked third and fourth respectively with prescriptions at UATH and NHA. The former was associated with more errors at the point of discharge. At the UCH, diuretics ranked third place followed by medicines for treating hypertension and heart failure. Similarly the latter was associated with more errors at the time of discharge.

A breakdown of the ten top categories of medications associated with prescribing errors is given below on Table 4.12.

Table 4.11 (a): Prescribing errors according to stage of patient stay, expressed as percentages of the number of orders in University College Hospital

Stage of patient stay	No. of medication orders	Serious errors N (%)	Other errors N (%)	Total errors N (%)	95% Confidence Interval Serious errors	Other errors	Total errors
Medication orders written on admission	2891	45 (1.6)	1203 (41.6)	1248 (43.2)	-2.07 to 5.27	38.81 to 44.39	40.45 to 45.95
Medication orders written during remainder of patients' stay	2769	37 (1.3)	599 (21.6)	636 (23.0)	-2.35 to 4.95	18.30 to 24.90	19.73 to 26.27
Medication orders written at discharge	1104	5 (0.5)	887 (80.3)	892 (80.8)	-5.68 to 6.68	77.68 to 82.92	78.22 to 83.38
TOTAL	**6764**	**87 (1.3)**	**2689 (39.8)**	**2776 (41.0)**	**-1.08 to 3.68**	**37.95 to 41.65**	**39.17 to 42.83**

Table 4.11b: Examples of errors identified in University College Hospital

Potentially serious prescribing errors	Less serious prescribing errors
▪ Serious drug interaction occurring from co-prescribing Amiodarone and Digoxin tablets; warfarin and carbamazepine.	▪ An adult male patient was prescribed Anthelmintics without specifying which one, and dose
▪ Azithromycin 500 mg tablet prescribed as tds instead of once daily for a patient with Steven-Johnson syndrome.	▪ IV Ceftazidime 750 mg daily was ordered in a patient's medical notes, but was transcribed in the treatment sheet as IV Ceftriazone 1 g daily
▪ IV Ciprofloxacin 500 mg q12h prescribed for a child less than 3years, resulting in overdose.	▪ A 5-year old child with bronchopneumonia was prescribed oral cefuroxime without specifying dose, frequency and duration.
▪ Potassium chloride (Slow K®) 600 mg qds tablets prescribed for a two and a half year old child.	▪ Co-prescribing a bacteriostatic and bacteriocidal antibacterial.
▪ Fesolate® 500 mg tablets tid prescribed for a 16-year old male.	▪ IV Fluid 250 mLs stat ordered for a child without stating which one.
	▪ Tab ceftriazone 1 g bd (wrong formulation) prescribed for demyelinating disease in an adolescent.

Table 4.12: Ten top categories of medicines associated with errors and their proportions

Drug category	UATH					NHA					UCH				
	A	**S**	**D**	**Total**	**%**	**A**	**S**	**D**	**Total**	**%**	**A**	**S**	**D**	**Total**	**%**
Antibacterials	620	128	48	796	**53.8**	354	187	96	637	**37.9**	634	316	63	1013	**36.3**
Fluid & electrolyte replacement (IV)	125	49	5	179	**12.1**	141	48	6	195	**11.6**	330	83	12	425	**15.2**
CVS (HTN & HF)	18	10	68	96	**6.5**	14	15	121	150	**8.9**	3	4	186	193	**6.9**
Oral anti-diabetic agents	30	30	16	76	**5.1**	25	24	25	74	**4.4**	2	2	49	53	**1.9**
Diuretics	31	12	18	61	**4.1**	15	5	21	41	**2.4**	104	28	89	221	**7.9**
Vitamins	11	6	27	44	**3.0**	8	8	34	50	**3.0**	8	4	147	159	**5.7**
Haematinics	5	9	24	38	**2.6**	3	6	54	63	**3.7**	17	16	97	130	**4.7**
Antimalarials	18	10	10	38	**2.6**										
Analgesics (non-opioid)	9	5	6	20	**1.4**										
Antisecretory and mucosal protectant						33	23	15	71	**4.2**					
Anti-tuberculosis	0	2	11	13	**0.9**										
Analgesics (opioid)						20	23	4	47	**2.8**	14	35	8	57	**2.0**
Anti-psychosis / antimaniacs						2	8	32	42	**2.5**					
Anti-diabetics (Insulin)											47	48	18	113	**4.1**
Antiplatelets											1	6	51	58	**2.1**

Key: Medications ordered at admission =A; During the ward stay =S; At discharge =D; IV=intravenous; CVS= Cardiovascular system; HTN= hypertension; HF= heart failure.

4.2.7 Relationship between length of hospitalization and error prevalence

Most errors generally occurred during the first two weeks of hospitalization than at subsequent times i.e. the incidence of errors decreased with increased length of ward stay with the lowest proportion recorded for periods between three weeks to one month. The incidence of errors varied with length of stay across the hospitals (Figure 4.1).

The mean number of ward days for patients in UATH was 10.74 days and the mean number of errors per patient per stay was 3.74 (Table 4.13). Pearson correlation test revealed no significant relationship between number of days spent and the incidence of errors ($p= 0.368$).

The mean number of ward days for patients in NHA was 10.39 days and the mean number of errors per patient per stay was 4.20. There was a significant relationship between the number of days of hospitalization and error incidence ($p< 0.0001$), suggesting that the proportion of errors was dependent on the number of days of admission (Table 4.13).

The mean number of ward days for hospitalized patients in UCH was 14.76 days and the mean number of errors per patient per stay was 6.97 (Table 4.13). There was a significant relationship between number of days spent and the incidence of errors ($p< 0.0001$**)**.

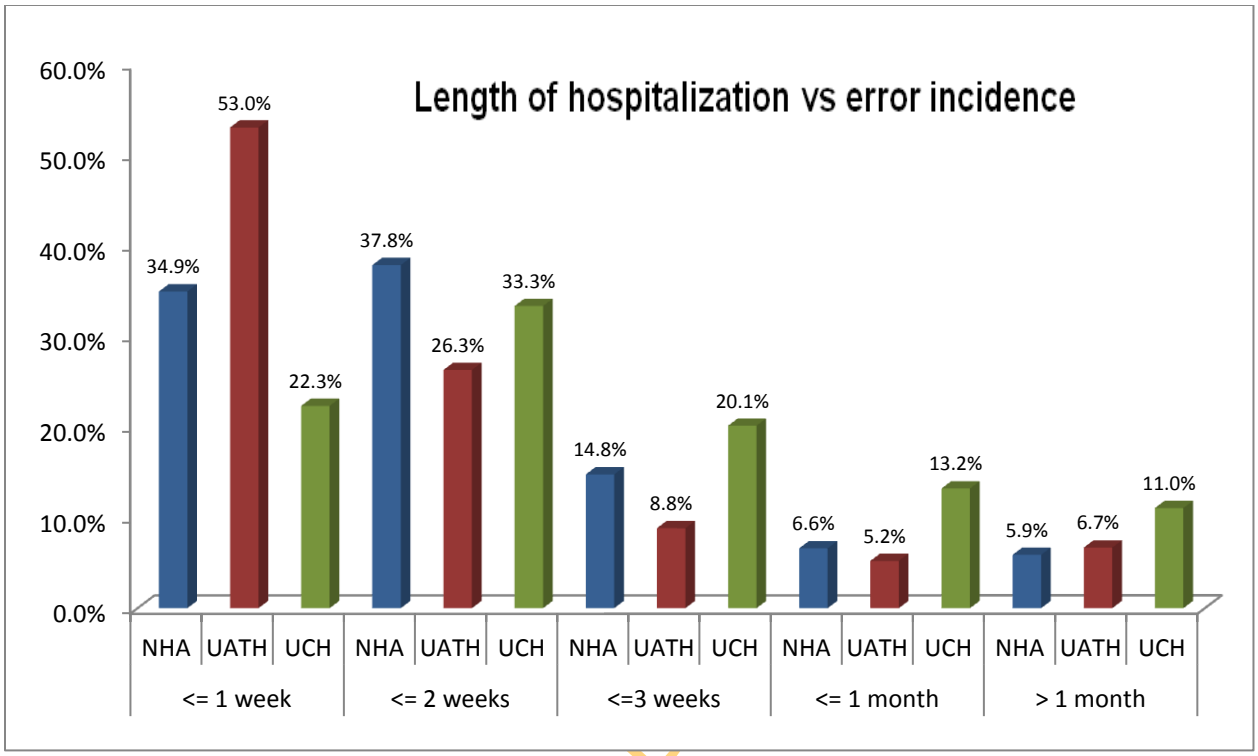


Figure 4.1: Length of hospitalization versus error incidence

Table 4.13: Relationship between length of hospitalization and error prevalence

Facility	Mean number of days of hospitalization (N +SD)	Errors (N +SD)	Number of Patients' Prescriptions
NHA	10.39± 9.247	4.20 ±3.525	400
UATH	10.74 ±3.477	3.74 ±2.623	400
UCH	14.76 ±11.608	6.97 ±3.474	400

UATH = University of Abuja Teaching Hospital; NHA = National Hospital Abuja; UCH = University College Hospital

4.3: Exploring the causes of prescribing errors

4.3.1 General

Ninety (90) errors involving 37 doctors were reported. In 15 cases, the prescribers could not be interviewed because, 7 were not identified, 3 were reported more than 72 hrs after the event, and in 5 cases the interviewers could not meet within the 72 hrs target period. Antibacterials, analgesics and cardio-vascular system (CVS) drugs accounted for over half the errors. House officers (HO) wrote most of the prescriptions although they were directed by their seniors. Sometimes, the HO determined the form, dose, route and frequency. Main factors involved with all prescribing errors are individual (16), team (14) and work environment (9) factors.

Forty nine (49) error incidents, involving 22 doctors, were analysed. Prescribers involved were 19 House officers (interns) and 3 Registrars while 21 of the incidents were medical cases. In all 22 cases, the prescribers were unaware that an error, lapse or mistake had occurred. Of the 22 incidents analysed (Table 4.14), one occurred on admission to the hospital and 21 during the in-patient stay.

Results are presented according to the Reason' accident causation model (Figure 2.2).

4.3.2 Active failures

Of the 49 prescribing errors detected from 113 medication orders evaluated during this study period, there was at least one active failure in each instance. Memory lapses (errors due to omission of a particular task) and slips (errors due to attention failure when performing a task or an active failure resulting from the incorrect execution of a task) were frequent and rule-mistakes also took place (Table 4.15).

All the 22 prescribers interviewed were unaware of the slip or lapse but however explained that they were rushing (6, 27%), or distracted during routine tasks (5, 23%). Common mistakes were errors of inappropriate dosing (10, 45%) and failure to check for potentially serious drug interactions (5, 23%). A common cause of RBM was the lack of knowledge of a relevant rule for example dose adjustment for patients with renal

impairment (3, 14%). Prescribing two or more drugs that could result in potentially serious interaction was also noted. For instance: carbamazepine and amitryptilline; nifedipine and atenolol; phenytoin and metronidazole. In the former case, the patient was being co-managed by the psychiatry and medical teams. The patient had been placed on carbamazepine as prophylaxis for his seizures, when the prescription for amitriptyline was added. Some junior doctors' responses suggested that they felt compelled to write what their seniors instructed even if at the back of their minds they felt 'somehow' about the order. There were instances where the correct rule was wrongly applied. For example, intravenous injection ceftriaxone dosing was misinterpreted as 20-50mg/kg twice daily instead of 20-50mg/kg daily in two divided doses. The prescriber multiplied the dose provided by the patient's weight and prescribed this amount to be given twice daily, instead of that total amount to be given in a day but in two divided doses, resulting in a two-fold overdose.

Another active failure showing lack of knowledge or experience (KBM) involved the use of 'IU' (short for international units), when prescribing insulin (3, 14%). Junior doctors claimed to be influenced by the practices of their senior colleagues in this, even though they agreed to the possibility of the orders being erroneously mis-read or mis-interpreted leading to a ten-fold error in dose. One interviewee stated that she tended to use abbreviation of drug names such as FSD instead of full strength Darrow's solution, NS instead of normal saline as a way to save time while writing.

4.3.3 Error-producing conditions

Many factors were cited as contributory to the errors, the most frequent being work environment (11, 50%), individual (10, 45%) and team (8, 36%). In 10 instances, high workload, resulting in multitasking was thought to have contributed to the error; in 5 instances the physical environment was cited. The terms 'hectic', 'busy', stressful' were used to describe workload (Table 4.16). Sometimes, the work situation made the junior doctors rush in their prescribing and other duties in order to catch up with their team. Part

of the pressure was to get the prescriptions written on time for the ward attendants to take the treatment sheets to pharmacy so that any medications requiring compounding would be presented in time before the 4.00pm shift was over. (In the hospital, morning shift is from 8.00am to 4.00pm).

Individual factors mentioned in connection with prescribing errors included physical and mental well being and lack of knowledge. Some 14 respondents mentioned tiredness (50%), distraction (29%), low morale (21%) and confused (14%), and that these factors may have caused the error. An absence of knowledge about dose and no prior experience of prescribing some drugs were contributory to errors. In 10 instances, junior doctors wrote prescription for drugs without indicating the route of administration and frequency of administration, claiming they had never prescribed the drug before or did not know the dose of the drug or the correct frequency of administration. In 9 instances, the HOs reported not having received any training in prescribing as undergraduates and five reported minimal training.

Team factors, such as communication, responsibility and supervision were associated with 12 incidents. Junior doctors commonly referred to communication about medications with words such as 'I wrote what was dictated to me by the Senior Reg', 'I was told by the Reg to leave it open'. Some junior doctors felt incompetent to disagree with the decisions of the seniors, did not feel it was correct to have a differing opinion from their superiors or even ask questions when they were not sure of the correct dose assuming that, to do so was to expose ignorance. In an instance, when acyclovir was prescribed by a HO for the first time, an error in the frequency of administration was made. When interviewed he claimed to have called the attention of the registrar to what he had written down and because the registrar had said it was 'o.k.', he did not take any further action. Junior doctors also felt that if a problem occurred, the seniors should take responsibility as the prescriptive authority. Other causes included lack of documentation of the prescribed medicine in the patient's notes. In some instances, supervision was inadequate as some senior doctors omitted to crosscheck what the junior ones prescribed or did.

Task and patient factors were mentioned as possible causes of errors. Task factors comprised the unavailability of drug reference materials such as the hospital formulary or standard treatment guidelines or similar document to consult at the point of prescribing. Inadequate patient information such as weight also made for dose calculation errors especially in paediatic patients where doses are usually calculated based on patients' weight. The absence of a local policy document meant they had to depend on other sources for information on doses, or copy from the seniors' prescribing- whether correct or not. In three instances, the patient was mentioned as a contributing factor. Two were being managed by two different specialist teams, while the third case was a complex one.

4.3.4 Latent underlying conditions

Lack of training in prescription writing skills and insufficient knowledge and experience about drugs were latent factors (Table 4.17). The junior doctors were left to fill all the details of strength, dose, form, frequency, route, duration and direction after verbal instructions were given. Usually, these orders were not cross-checked by the seniors.

Doctors also showed a low consciousness of making errors. For instance, only two of the interviewees agreed to sometimes (10-20% of the time) making prescribing errors while the rest claimed they rarely (less than 5%) or seldom (5-10%of the time) made errors (See Questionnaire, Appendix K). Considering that a non- discriminatory prescribing error rate of 26.3% for in-patient medication orders in National hospital was determined, this point of view seemed improbable.

The workload and long working hours resulting in physical and mental stress are factors highlighted. Also the location of the treatment sheets in the wards was a contributory latent factor as reported by one HO who felt unfamiliar with this practice in NHA as opposed to what was obtained elsewhere. Treatment sheets and drug administration records were not kept by the individual patients' bedside but in a pool at the nurses' station.

4.3.5 Violations

Violations were identified (Table 4.17). A frequent violation was the omission of duration of therapy for antibiotic orders (11, 50%) and intravenous infusions. Some interviewees suggested that this practice was promoted by their seniors who felt that such open-ended practice made it easier to review patients' progress at the daily ward rounds until discharge.

4.3.6 Defences

Self-initiated defences by three doctors included re-checking their own orders, one mentioned reading out the order silently to herself before signing it. Two mentioned nurses as sources of defence who reportedly helped prevent some mistakes from reaching patients in the past. Pharmacists were also mentioned as key sources of defences (Table 4.17) as doctors cited instances where they had called the pharmacy units to get help with some drug doses/other information. Other doctors were also cited as defences for their colleagues by identifying and preventing transcription errors.

Table 4.14: Prescribing errors and analysis by themes from interviews with prescribers

Stage of Error	Context of Error	Prescriber	Directed by Senior	Prescribed before?	Themes underlying error
On admission					
1. IVF Dextrose 5%, Cinnarizine (Stugeron®), Tramadol	Duration/stop-date omitted, dose inappropriate	Registrar	No	Yes	Training, chore, supervision, absence of guidelines
During ward stay					
2. Lisinopril	Dose inappropriate	House Officer	Yes	Yes	Multitasking, supervision, absence of error awareness
3. Tramadol	Dose adjustment in renal impairment	House Officer	Yes	No	Supervision, communication, training
4. Amoxicillin+clavulanic acid, Soluble Insulin, IVF Normal saline	Duration of therapy omitted + unsafe abbreviation	House Officer	Yes	Yes	Training, absence of guidelines, supervision
5. Erythromycin, Metronidazole, Amoxicillin + clavulanic acid	Duration of therapy omitted	House Officer	Yes	Yes	Training, supervision, communication, absence of guidelines
6. Ceftriaxone	Dose adjustment in renal impairment; stop-date omitted	House Officer	Yes	Yes	Lack of knowledge, training, supervision, communication
7. Ceftriaxone, Ranitidine	Duration of therapy omitted, need for therapy omitted	House Officer	Yes	No	Training, supervision, absence of error awareness

Stage of Error	Context of Error	Prescriber	Directed by Senior	Prescribed before?	Themes underlying error
8. Tramadol	Transcription error, route of administration omitted	House Officer	Yes	No	Absence of error awareness, lack of knowledge, supervision, inattention
9. Insulin	Unsafe abbreviation	House Officer	Yes	Yes	Training, supervision, absence of guidelines
10. Domperidone, Nifedipine + Atenolol	Dose inappropriate, drug-drug interaction	House Officer	Yes	No	Lack of knowledge, supervision
11. Nifedipine + Nimodipine, Enoxaparin	Need for drug therapy omitted; Drug-disease contraindication	House Officer	Yes	No	Lack of knowledge, absence of reference material, supervision, communication,
12. Amoxicillin + clavulanic acid	Dose inappropriate	House Officer	Yes	Yes	Communication, supervision, trust in seniors
13. Carbamazepine + Amitriptiline	Drug – drug interaction	Registrar	Yes	No	Absence of reference books, co-managed patient, communication
14. Aciclovir	Dose inappropriate	House Officer	Yes	No	Trust in senior, nurse defense over-ridden, supervision
15. Ceftriaxone, Metronidazole, Gentamycin	Dose inappropriate, duration/stop-date omitted, transcription error	House Officer	Yes	Yes	Absence of error awareness, lack of knowledge of patient, chore, supervision
16. Metoclopramide, Hyoscine butyl bromide	Route of administration omitted, inappropriate dose	House Officer	Yes	No	Supervision, rushed, training, lack of knowledge

Stage of Error	Context of Error	Prescriber	Directed by Senior	Prescribed before?	Themes underlying error
17. Risperidone, Phenytoin, Metronidazole	Drug – drug interaction	House Officer	Yes	No	Lack of knowledge, training, supervision, chore, co-managed patient
18. Imipenem	Dose inappropriate	House Officer	Yes	No	Communication, absence of error awareness, multitasking, supervision
19. Diclofenac, Warfarin, Enoxaparin	Drug-drug interaction	Registrar	No	Yes	Supervision / responsibility, absence of error awareness
20. Rabeprazole + Omeprazole	Duplication, need for drug omitted	House Officer	Yes	No	Lack of knowledge, communication, supervision, chore
21. Insulin, Metronidazole	Unsafe abbreviation, duration/stop-date omitted	House Officer	Yes	Yes	Training, supervision, chore
22. Naproxen + Aspirin + Tramadol	Drug-drug interaction	House Officer	Yes	No	Lack of knowledge, training, supervision

IVF = Intravenous fluid

Table 4.15: **Examples of active failures**

Errors
Slips
"I was writing a prescription for IV Frusemide 120 mg b.d. when a nurse talked to me…I can't really remember what happened to have caused the mix-up but I was trying to catch up with the team. I don't know how I mixed up the dose meant for frusemide for lisinopril". (Interview 1, House officer, researcher's notes).
Lapses
"I am not used to giving tramal® (tramadol) as an injection… I had to ask the SR, and he said injection but I didn't confirm the route. But I can remember the prescription clearly. He said 100 mg stat and 50 mg t.d.s per oral for 3 days. Two of us were taking the instruction. I wrote in the folder and my colleague in the treatment sheet". (Interview 7, House officer, researcher's notes).
Mistakes
Some mistakes resulted from an absence of knowledge of correct dose, or relevant rules:
"I don't know exactly where this error is from. I can't say whether the child was on 350 mg IV ceftriazone elsewhere and I copied the prescription…IV ceftriazone is given at a dose of 50-75 mg most times but in meningitis can go as high as 100 mg/kg. That's what my Reg says…I think in this case calculating my own dose would have helped, but if the managing team has a reason for a different dose, I may have to know why…" (Interview 14, House officer, researcher's notes).
When asked to explain his mistake a HO did not know that Clexane® is the brand name for Enoxaparin. "The patient was thought to have pulmonary embolism in addition to his stoke…It was agreed it won't be appropriate to give this patient clexane because of his internal bleed….I am not aware that enoxaparin is the active ingredient in clexane.." (Interview 9, House officer, researcher's notes).
"This patient was formerly on nifedipine 20 mg b.d. and we later increased it to 30 mg (with improvement in the blood pressure control). Then nimodipine was added. My SR said nimodipine was for the headache not as an anti-hypertensive. Later I called him to confirm the dose and he said we should give 50 mg q 6rs x 1/52…..I also thought about the drug being a CCB (same class as nifedipine) but my SR said it was o.k…… We felt the drug (nimodipine) was needed because the patient was complaining of headache and stiffness around the neck so we thought of sub-arachnoid haemorrhage". [Patient with right hemispheric haemorrhagic stroke] (Interview 8, House officer, researcher's notes).

SR= Senior Registrar; Reg = Registrar; NS = Normal saline; F/S Darrows = Full strength Darrow's solution; IU = International units; CCB = Calcium-channel blocker; Frusemide = Furosemide.

Table 4.16: Examples of error- producing conditions

Environment factors
"There was a lot of distraction in the ward… (Interview 2, House officer, researcher's notes).
Individual factors
"When more than one person talks to me at the same time, I tend to get distracted…I can get them to please pause and take it one-by-one. Also if my reg is too fast, I can slow him down so I get it". (Interview 2, House officer, researcher's notes).
"The metoclopramide was prescribed earlier and that had the route of administration, dose, etc. So I omitted writing that (route of administration) but it would have been better to have included the route. I may have been rushing to write the prescription before it goes to pharmacy". (Interview 15, House officer, researcher's notes).
Team factors
"It was a team decision, I was just the writer. The prescription was not written same day. The carbamazepine was for prophylaxis because the patient had seizures in the past and amitryptilline was prescribed two days ago because the patient was manifesting symptoms of depression….It must have been an oversight because such (interaction between carbamazepine and amitryptilline) had been mentioned to us before. But like I said, I was the writer; the decision wasn't taken by me". (Interview 11, Registrar, researcher's notes).
Task factors
"I discussed with my SR and he made a suggestion of not using the commonly used NSAIDs. He suggested the tramadol. We made a change on this to DF118® due to intractable vomiting. I omitted to write this (the substitution) in the patient's folder". (Interview 3, House officer, researcher's notes).
Patient factors
Patient being co-managed by two different specialties.
"The dose of phenytoin was initiated at the A&E to treat seizures. It was 100 mg b.d. Risperidone was later ordered by the psychiatrist but I wrote it down. I had a thought about it (the combination) but being a House officer, I can't question a Consultant's order. (Interview 17, House officer, researcher's notes).

NSAIDs = Non-steroidal anti-inflammatory drugs; DF 118 = Dihydrocodeine tartrate tablets; A&E = Accident & Emergency unit.

Table 4.17: **Examples of latent conditions and defences**

Latent condition
When asked what the prescriber felt would help in preventing a repeat of the dosing error made:
"Providing a small booklet of medicine information or drug reference such as EMDEX or the hospital's formulary will be helpful". (Interview 9, House officer, researcher's notes).
"I have had no prior training on drug prescribing. Just pharmacology where we were taught about pharmacology of drugs, dose, side effects etc. (Interview 14, House officer, researcher's notes).
Violations
"I remember writing the prescription. We were rushing to the next patient…..two nurses were talking to me, the Reg was waiting for me to write, so I got distracted. I was rushing to write fast. I use abbreviation to make me write faster… [Abbreviations such as NS, F/S Darrows, Insulin 8IU].(Interview 2, House officer, researcher's notes)
"Most times our seniors tell us to prescribe (an antibacterial) and to leave it open. I prescribe that way because in most cases duration (of therapy) is not given….I tend not to write the duration because that's the way I'm told". (Interview 3, House officer, researcher's notes).
"The wafarin was to commence on the 3rd day after we started the enoxaparin. I noted it in the patient's folder as such but a Corper (senior house officer) copied this into the treatment sheet. Maybe he didn't note that fact….I did not cross-check to know what the Corper had written in the treatment sheet". (Interview 18, Registrar, researcher's notes).
Defences
Nurses
When asked if the prescriber had ever been involved in an error incidence;
"Yes, it was an IVF. It was meant to be given 12 hourly but I wrote 2 hourly. The matron corrected me and I changed it immediately". (Interview 13, House officer, researcher's notes).
"I called the attention of my Reg to the dose (of acyclovir) and he said it can be taken 200 mg t.d.s. The Nurses also called our attention to this but my Reg said it was ok….This is my first time of prescribing this drug. (Interview 12, House officer, researcher's notes).
Pharmacists
"The prescription was mis-written as bendrofluthiazide 50 mg (when 5mg was intended) and given to the patient. The error was detected at the pharmacy department and prevented from reaching the patient". (Interview 5, Registrar, researcher's notes).

IVF = Intravenous fluid; EMDEX = The Complete DRUG FORMULARY for Nigeria's Health Professionals (based on WHO Model Formulary); NS = Normal Saline; F/S = full strength.

4.4: Results of Prospective study to determine the impact of the intervention

4.4.1 Impact of the intervention on NHA doctors' prescription error types and rates

Baseline prescribing errors were determined and grouped into categories for the six pre-intervention months and compared with prescribing error rates post-intervention. Results showed that overall, there was no change in prescribing error rates post-intervention (p=0.984). However, statistically significant error reductions were obtained for errors involving omission of route of administration (p< 0.001), underdose (p=0.012), dose adjustment in renal impairment (p=0.019), ambiguous orders (p<0.001) and drug/drug interaction (p<0.001). Other statistically significant error reductions were wrong drug and extended duration (Table 4.18).

4.4.2 Pre and post intervention prescribing error rate in University College Hospital

At the UCH (control site), total prescribing errors increased from 441 (21.7%) during the pre-intervention 6-month period to 438 (22.7%) post-intervention. This was not statistically significant (p= 0.128) (Table 4.19).

4.4.3 Pre and post intervention prescribing error rate in University of Abuja Teaching Hospital

Similarly at the UATH, total prescribing errors increased from 270 (13.08%) during the pre-intervention 6-month period to 347 (13.13%) post-intervention. This was not statistically significant (p= 0.912) (Table 4.20).

Table 4.18: Pre and post Intervention error types and rates in National Hospital Abuja

TYPE OF ERRORS	No. of errors Pre-I	Error rate for pre-I (%)	No. of errors Post-I	Error rate for post-I (%)	% Difference	95% CI		p-value
						Lower	Upper	
Incomplete								
Omission of duration/stop date	36	1.97	56	3.26	-1.29	-1.92	-0.65	<0.001
Dose/freq omitted	2	0.11	3	0.17	-0.06	-0.22	0.09	0.2225
Drug name omitted	0	0.00	0	0.00	0.00	0.00	0.00	
Route omitted	6	0.33	1	0.06	0.27	0.01	0.53	<0.001
Direction for use omitted	0	0.00	1	0.06	-0.06	-0.06	-0.06	0.016
Dosing								
Dose inappropriate (underdose)	8	0.44	4	0.23	0.21	-0.10	0.51	0.0121
Dose inappropriate (overdose)	5	0.27	6	0.35	-0.08	-0.32	0.16	0.3421
Dose adj. in renal impairment	1	0.05	0	0.00	0.05	-0.05	0.16	0.0193
Dose adj. in liver disease	0	0.00	1	0.06	-0.06	-0.06	-0.06	0.016
Ambiguous								
Ambiguous order	4	0.22	0	0.00	0.22	0.00	0.43	<0.001
Interaction								
Drug/Drug Interaction	22	1.21	6	0.35	0.86	0.36	1.36	<0.001
Abbreviation								
Unsafe abbreviation	7	0.38	9	0.52	-0.14	-0.42	0.14	0.1416

TYPE OF ERRORS	No. of errors Pre-I	Error rate for pre-I (%)	No. of errors Post-I	Error rate for post-I (%)	% Difference	95% CI		p-value
						Lower	Upper	
Others								
Wrong route	0	0.00	1	0.06	-0.06	-0.06	-0.06	0.016
Therapeutic duplication	6	0.33	8	0.47	-0.14	-0.40	0.13	0.126
Transcription error	5	0.27	3	0.17	0.10	-0.14	0.34	0.1362
Extended duration	1	0.05	0	0.00	0.05	-0.05	0.16	0.0193
Wrong formulation	2	0.11	0	0.00	0.11	-0.04	0.26	<0.001
Total	**105**	**5.76**	**99**	**5.76**	**-0.01**	**-1.07**	**1.06**	**0.984**

Table 4.19: Pre and post Intervention error types and rates in University College Hospital

TYPE OF ERRORS	No. of errors Pre-I	Error rate for Pre-I (%)	No. of errors Post-I	Error rate for Post-I (%)	% Difference	95% CI		p-value
						Lower	Upper	
Incomplete								
Omission of duration/stop date	391	19.24	398	20.64	-1.40	-3.12	0.31	0.0264
Drug name omitted	1	0.05	0	0.00	0.05	-0.05	0.15	0.0264
Route omitted	0	0.00	0	0.00	0.00	0.00	0.00	
Direction for use omitted	3	0.15	0	0.00	0.15	-0.02	0.31	<0.001
Dosing								
Dose inappropriate (underdose)	4	0.20	1	0.05	0.14	-0.05	0.34	0.0036
Dose/freq omitted	20	0.98	20	1.04	-0.05	-0.48	0.38	0.7114
Dose inappropriate (overdose)	7	0.34	6	0.31	0.03	-0.22	0.29	0.6818
Dose adj. in Renal Impairment	0	0.00	0	0.00	0.00	0.00	0.00	
Ambiguous								
Ambiguous order	2	0.10	2	0.10	-0.01	-0.14	0.13	0.9045
Interaction								
Drug/Drug Interaction	6	0.30	2	0.10	0.19	-0.04	0.43	0.0024
Abbreviation								
Unsafe abbreviation	4	0.20	4	0.21	-0.01	-0.20	0.18	0.865
Others								
Wrong route	0	0.00	0	0.00	0.00	0.00	0.00	
Therapeutic duplication	2	0.10	0	0.00	0.10	-0.04	0.23	0.0017
Transcription error	1	0.05	4	0.21	-0.16	-0.25	-0.06	0.0018
Wrong formulation	0	0.00	1	0.05	-0.05	-0.05	-0.05	0.0226
Total	**441**	**21.70**	**438**	**22.72**	**-1.02**	**-2.81**	**0.78**	**0.1285**

Table 4.20: Pre and post Intervention error types and rates in University of Abuja Teaching Hospital

TYPE OF ERRORS	No. of errors Pre-I	Error rate for Pre-I (%)	No. of errors Post-I	Error rate for Post-I (%)	% Difference	95% CI		p-value
						Lower	Upper	
Incomplete								
Omission of duration/stop date	183	8.86	292	11.05	-2.19	-3.41	-0.96	<0.001
Dose/freq omitted	16	0.77	3	0.11	0.66	0.28	1.04	<0.001
Drug name omitted	2	0.10	0	0.00	0.10	-0.04	0.23	0.0019
Route omitted	1	0.05	3	0.11	-0.07	-0.16	0.03	0.1052
Direction for use omitted	1	0.05	4	0.15	-0.10	-0.20	-0.01	0.0214
Dosing								
Dose inappropriate (underdose)	25	1.21	10	0.38	0.83	0.36	1.30	<0.001
Dose inappropriate (overdose)	9	0.44	7	0.26	0.17	-0.11	0.46	0.0414
Dose adj. in renal impairment	0	0.00	2	0.08	-0.08	-0.08	-0.08	0.006
Ambiguous								
Ambiguous order	2	0.10	1	0.04	0.06	-0.08	0.19	0.1074
Interaction								
Drug/Drug Interaction	12	0.58	3	0.11	0.47	0.14	0.80	<0.001
Abbreviation								
Unsafe abbreviation	17	0.82	20	0.76	0.07	-0.32	0.46	0.5961
Others								
Indicated drug not given	0	0.00	1	0.04	-0.04	-0.04	-0.04	0.0512
Wrong route	2	0.10	0	0.00	0.10	-0.04	0.23	0.0019
Therapeutic duplication	0	0.00	1	0.04	-0.04	-0.04	-0.04	0.0512
Total	**270**	**13.08**	**347**	**13.13**	**-0.05**	**-1.51**	**1.40**	**0.9124**

4.4.4 Impact of intervention on prescriber category

At the NHA, the study revealed that junior doctors (HOs and registrar) were responsible for writing most of the prescriptions generated in the in-patient, pre-intervention (81, 77.1%) as well as post-intervention (82, 82.8%). Un-identified prescribers were responsible for 22.9% of prescriptions written pre-intervention and 17.2% post-intervention (Table 4.21). The overall in-patient prescribing error rate for NHA prescribers was 5.8%.

The prescriber category with the highest reduction in prescription error rates post-intervention was the registrars (0.93% to 0.29%, $p< 0.001$). Error rate by house officers increased from 3.51% to 4.48%. The unidentified category of prescribers gave a reduction in error rate from 1.32% to 0.99% and this was statistically significant. The overall difference in prescribing error rate pre- and post- intervention was not statistically significant ($p= 0.98$).

Similarly at the UCH, junior doctors were responsible for writing most in-patient prescriptions (65.3%; 74.2% pre and post-intervention respectively). Unidentified prescribers wrote 31.5% and 15.7% of prescriptions pre and post intervention respectively (Table 4.22). Prescribing error rates were significantly reduced for registrars and unidentified prescribers ($p< 0.001$). The overall prescribing error rate for the 12-months was 22.2%. The difference in error rates for the pre and post periods was not statistically significant ($p= 0.13$).

Junior doctors were responsible for writing majority of the in-patient prescriptions at the UATH (75.6%: 75.5% pre and post-intervention respectively). Unidentified prescribers wrote 19.6% and 20.7% of prescriptions pre and post intervention respectively (Table 4.23). Statistically significant reduction in error rates were obtained for registrars and consultants ($p< 0.001$) only. The overall in-patient prescribing error rate for the study period was 13.1%. The percentage reduction in error rates pre and post-intervention was not statistically significant ($p= 0.912$).

Table 4.21: Pre and post Intervention prescriber category error rates in NHA

Physician	No. of errors Pre-I	Error rate for Pre-I (%)	No. of errors Post-I	Error rate for post-I (%)	% Difference	95% CI		p-value
						Lower	Upper	
House Officer	64	3.51	77	4.48	-0.97	-1.82	-0.13	<0.001
Medical officer	0	0.00	0	0.00	0.00	0.00	0.00	
Registrar	17	0.93	5	0.29	0.64	0.20	1.08	<0.001
Senior registrar	0	0.00	0	0.00	0.00	0.00	0.00	
Consultant	0	0.00	0	0.00	0.00	0.00	0.00	
Prescriber not identified	24	1.32	17	0.99	0.33	-0.20	0.85	0.0316
Total	**105**	**5.76**	**99**	**5.76**	**-0.01**	**-1.07**	**1.06**	**0.984**

Table 4.22: Pre and post Intervention prescriber category error rates in UCH

Physician	No. of errors Pre-I	Error rate for Pre-I (%)	No. of errors Post-I	Error rate for Post-I (%)	% Difference	95% CI		p-value
						Lower	Upper	
House Officer	236	11.61	304	15.77	-4.15	-5.55	-2.76	<0.001
Medical officer	0	0.00	0	0.00	0.00	0.00	0.00	
Registrar	52	2.56	21	1.09	1.47	0.78	2.16	<0.001
Senior registrar	14	0.69	44	2.28	-1.59	-1.95	-1.23	<0.001
Consultant	0	0.00	0	0.00	0.00	0.00	0.00	
Prescriber not identified	139	6.84	69	3.58	3.26	2.16	4.36	<0.001
Total	**441**	**21.70**	**438**	**22.72**	**-1.02**	**-2.81**	**0.78**	**0.1285**

Table 4.23: Pre and post Intervention prescriber category error rates in UATH

Physician	No. of errors Pre-I	Error rate for Pre-I (%)	No. of errors Post-I	Error rate for Post-I (%)	% Difference	95% CI		p-value
						Lower	Upper	
House Officer	159	7.70	223	8.44	-0.74	-1.89	0.41	0.0658
Medical officer	2	0.10	6	0.23	-0.13	-0.26	0.00	0.022
Registrar	43	2.08	33	1.25	0.83	0.22	1.45	<0.001
Senior registrar	8	0.39	13	0.49	-0.10	-0.37	0.16	0.267
Consultant	5	0.24	0	0.00	0.24	0.03	0.45	<0.001
Prescriber not identified	53	2.57	72	2.72	-0.16	-0.84	0.52	0.4902
Total	**270**	**13.08**	**347**	**13.13**	**-0.05**	**-1.51**	**1.40**	**0.9124**

4.4.5 Summary of findings – University of Abuja Teaching Hospital

The study examined 4,708 prescriptions for 750 patients. The research found that 1 in 8 prescriptions contained a prescribing error effecting 1 in 22 patients (Table 4.24).

4.4.6 Summary of findings – National Hospital Abuja

The study examined 3,542 prescriptions for 630 patients. The research found that 1 in 17 prescriptions contained a prescribing error effecting 1 in 44 patients (Table 4.25).

4.4.7 Summary of findings – University College Hospital

The study examined 3,960 prescriptions for 560 patients. The research found that 1 in 5 prescriptions contained a prescribing error effecting 1 in 14 patients (Table 4.27).

Table 4.24: Summary of findings – University of Abuja Teaching Hospital

	Months												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
a)Total no of patients in the study wards	64	60	30	66	63	64	54	62	64	65	72	86	**750**
b)Total medicines prescribed for (a)	321	358	211	362	450	363	407	418	432	425	405	556	**4708**
c)No of patients with errors in prescribed medicines	14	16	14	17	11	26	22	18	16	21	27	17	**219**
d)Total prescribed medicines for (c) above	55	80	78	94	79	147	193	124	131	144	151	115	**1391**
e)No of prescribing errors identified in (d)	31	31	37	49	31	91	65	61	50	56	68	47	**617**

Table 4.25: Summary of findings – National Hospital Abuja

	Months												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**`10**	**11**	**12**	**Total**
a)Total no of patients in the study wards	53	52	54	49	56	51	55	52	55	54	51	48	**630**
b)Total medicines prescribed for (a)	258	309	347	333	311	266	320	265	259	317	283	274	**3542**
c)No of patients with errors in prescribed medicines	16	9	6	2	2	2	10	7	11	6	2	8	**81**
d)Total prescribed medicines for (c) above	80	57	43	14	11	10	58	35	53	36	5	47	**449**
e)No of prescribing errors identified in (d)	40	17	20	7	9	12	36	14	21	11	3	14	**204**

Table 4.26: Summary of findings - University College Hospital

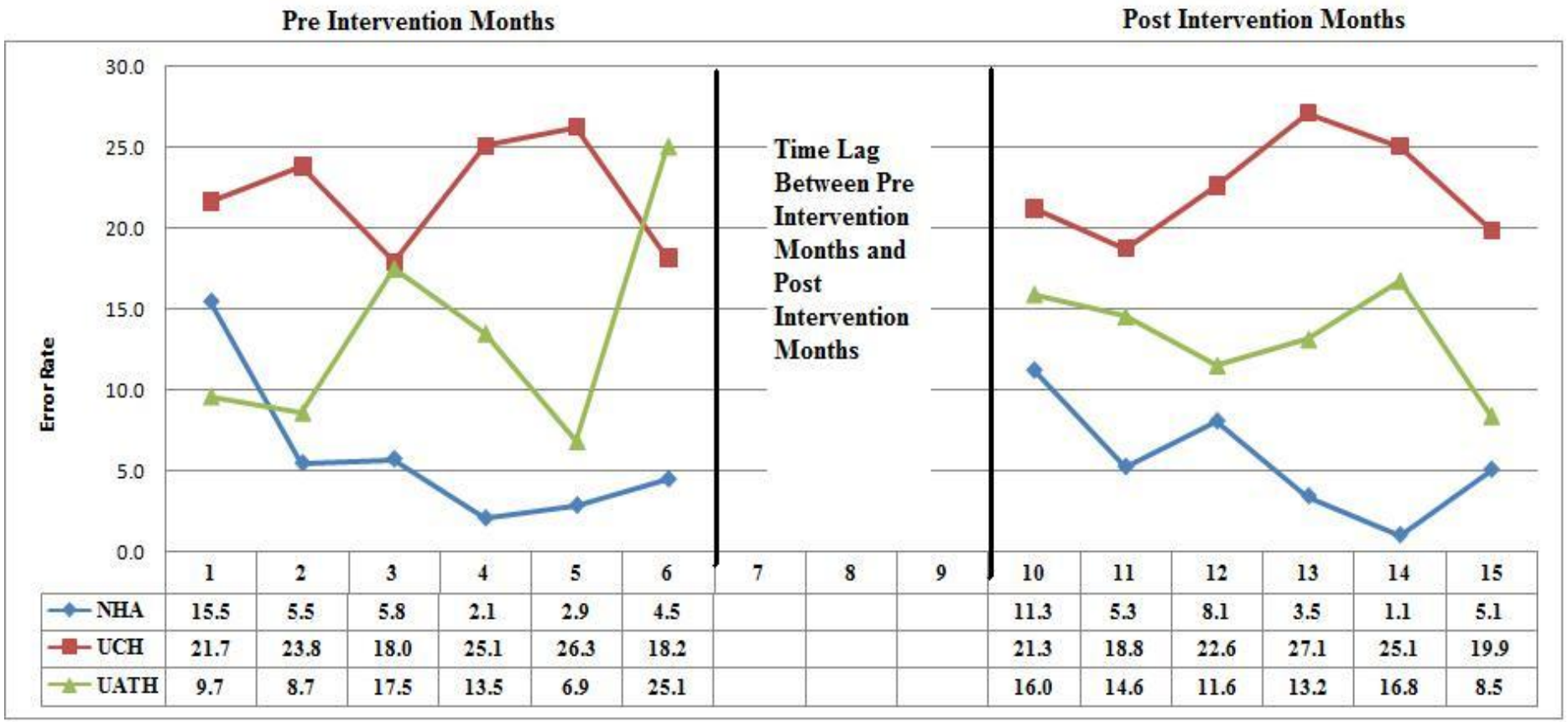
	Months												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**`10**	**11**	**12**	**Total**
a)Total no of patients in the study wards	51	48	66	29	46	47	45	27	46	49	55	51	**560**
b)Total medicines prescribed for (a)	355	298	462	251	320	346	334	213	318	343	363	357	**3960**
c)No of patients with errors in prescribed medicines	19	23	26	17	24	23	23	14	24	29	32	24	**278**
d)Total prescribed medicines for (c) above	133	140	189	157	166	185	173	122	161	203	205	167	**2001**
e)No of prescribing errors identified in (d)	77	71	83	63	84	63	71	40	72	93	91	71	**879**

4.4.8 Overall impact of the intervention at National Hospital Abuja

The study showed that at baseline, prescribing error rates was lowest at the NHA followed by UATH and highest for UCH prescribers (Figure 4.5). There was a steep drop in error rates at the commencement of the study at NHA (from 15.5% to 5.5%), and error rates subsequently ranged between 5.8% and 2.1% during the pre-intervention months. Error rates at the control sites of UATH and UCH ranged from 6.9% to 25.1% and 18.0 to 26.3% respectively during the pre-intervention months.

Error rates at NHA ranged from 1.1% to 11.3% during the 6-month post-intervention data collection. The increase in error rate at the 3rd month post-intervention coincided with the arrival of new sets of HOs, midyear 2012. Error rates post-intervention gave a similar downward trend as the previous period. Error rates post-intervention months remained fairly comparable to the pre-intervention rates at the UCH (18.8% to 27.1%) and ranged from 8.55 to 16.8% at the UATH (Figure 4.5).

Overall, the intervention did not result in a statistically significant change in error rate at the NHA.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
NHA	15.5	5.5	5.8	2.1	2.9	4.5				11.3	5.3	8.1	3.5	1.1	5.1
UCH	21.7	23.8	18.0	25.1	26.3	18.2				21.3	18.8	22.6	27.1	25.1	19.9
UATH	9.7	8.7	17.5	13.5	6.9	25.1				16.0	14.6	11.6	13.2	16.8	8.5

Figure 4.2: Pre- and post intervention error rates per hospital

CHAPTER FIVE

DISCUSSION

5.1 Incidence of prescribing errors

This study found that prescribing errors commonly occurred in both out-patient and in-patient prescriptions of the three hospitals, independent of whether they caused harm or not. Even though the error rate per hospital differed, there was similarity in the trend by which these errors occurred. Mean prescribing error rates determined for outpatient prescriptions and in-patient medication orders (Tables 4.2 and 4.7) were high compared to some published work arising from the US or UK (Lesar et. al., 1997, Kaushal et. al., 2001, Dean et. al., 2002, Bobb et. al., 2004), although there were differences in the definition of prescribing error used. These studies reported prescribing error rates of 0.3 to 9.1% of medication orders written for hospital inpatients and in 1 to 100% of admissions. However, it was comparable with other studies from developing nations which determined prescribing error rates of 32.9% (Sanguansak et. al., 2012), 40% (Al-Hajje et. al., 2012), 41.3% (Sapkota et. al., 2011), 84.7% (Al Khaja et. al., 2005) and from North East England with a prescribing error rate of 43.8% (Seden et. al., 2013). There are no previous published studies on prescribing error rates in Nigeria hospitals, by which comparisons could be made. Although some researchers such as Erhun et. al. (2009) and Oshikoya and Ojo (2007) have reported on prescribing errors in paediatric and general out-patient prescriptions in some Nigerian tertiary hospitals, these studies did not include prescribing error rates amongst prescribers.

Nonetheless, when considering clinical severity only few inpatient prescriptions were judged serious. It is important to note that the severity rating related to the potential severity had the error been allowed to progress through to the patient. Appendix C

gives the Error Severity Classification Scheme, developed by some researchers in the UK, used in categorizing the errors.

5.1.1 Types of prescribing errors

The most common type of medication prescribing errors detected amongst the prescribers in the three hospitals was incomplete prescribing information or omission errors. The study revealed a high tendency to omit necessary information such as omitting to write patient age, weight and sex, omitting to give direction for use for instance, in prescribing oral rehydrating salts (ORS) for dehydration arising from frequent stooling or vomiting and omitting to state how the patient is to take their medications. Others included omission of duration or stop date of treatment (especially for antibiotics administered via the parenteral routes), omission of prescriber information (name and signature of prescriber), omission of route of administration for medicine such as. furosemide, diazepam and phenytoin which can be administered through more than one route and omission of dose or frequency of administration of a medicine.

In a study carried out in the US, Condren et. al. (2010) reported that the most common type of error was incomplete prescription followed by dosing errors. Their study, which reported a prescribing error rate of 9.7%, highlighted incomplete prescriptions as omission of drug dose or strength, route of administration and pertinent patient information. Ghaleb et. al. (2010) in a UK study involving paediatric in-patients, reported incomplete prescription as the most common type of prescribing error. Similarly, Oshikoya and Ojo (2007) whose study was undertaken at Lagos State University Teaching Hospital, Nigeria also identified omission of patient age, dosage and duration of drug use as important prescribing errors.

Other researchers have reported a similar tendency by prescribers to omit necessary information when writing prescriptions in studies carried out in Nepal (Sapkota et. al., 2011), Australia (Baysari et. al., 2012), England (Sanghera et. al., 2007; Seden et. al., 2013), Mexico (Corona-Rojo et. al., 2009), USA (Lee et. al., 2009), Saudi Arabia (Irshaid et. al., 2005) Nigeria (Akoria and Isa, 2008) and Bahrain (Al Khaja et. al., 2005). Since the error of omission appear to be wide-spread among prescribers, it is

important to find out why this is so. This underscores the importance of audit and feedback to prescribers as a means of highlighting and correcting these lapses.

Omission of prescriber signature or name: This gives rise to the question of the legality of such prescriptions. It is a requirement by law that prescriptions arising from licensed physicians should be duly signed failure of which, ideally, a pharmacist may not dispense. Erhun et. al. (2009) reported a similar observation amongst prescribers in a tertiary hospital in South West Nigeria. The Nigeria Standard Treatment Guideline, 2008 states the identity of the prescriber as one of the essential elements of a prescription order. A medical order is valid only if a medical practitioner enters all the required items.

Omission of patient age: The practice commonly observed was to write 'Adult' on the space provided for age on prescriptions. To the uninformed, this may appear trivial but it must be said that there is a difference between a man or woman aged 18 and 80 even though both are referred to as "adult". In this era of geriatric medicine and with the knowledge of the decline in functions of body organs such as the kidneys with age, it is important to signify the exact age of a patient to be able to provide appropriate dosage based on pharmacokinetic parameters of the individual patient. It is well reported in literature that extremes of age in paediatric and geriatric populations are at greater risk of ADRs with modern medicines aside from the rising incidence of polypharmacy (Oshikoya et. al., 2007).

Likewise, in the British National Formulary (BNF), the guidance on prescribing entails stating the age and date of birth of patients. In the case of prescription-only medicines, it is a legal requirement to state the ages of children under 12 years. Our prescribers need to be reminded of these requirements and efforts directed at ensuring compliance.

Omission of patient gender: Many of the out-patient prescription orders omitted to state the sex of the patient. The UCH prescription sheets particularly did not have an entry for patient's sex (Appendix F). Pre-printed prescription sheets should be appropriately designed and provided with entries for all required items to avoid errors that may arise from such omissions. Indication of sex will inform the pharmacist to give more detailed and specific instructions especially when dispensing certain

medications like vaginal pessaries, aphrodiascs or medicines known to be specific for males such as finasteride which should not be handled by pregnant women or those of childbearing age. An upgrading of these prescription forms is indicated to fore-stall errors that may harm patients as a result of this omission.

Omission of duration of therapy/stopdate:

Prescriptions involving antimicrobials (oral and parenteral) produced the bulk of errant prescriptions. Common cases were errors of inappropriate dosing and omission of duration of use. The decision to prescribe an antimicrobial should always be clinically justified and the reason(s) should be recorded in the patient's medical record. It is important not to prescribe antimicrobials on a 'just in case' basis. There is now evidence to support the notion that overprescribing and inappropriate usage is generally the main driver of increased resistance to antimicrobials (SHEA Policy Statement, 2012).

Antimicrobial prescribing should include essential information on dose, route and duration of therapy as well as the appropriate selection of the antimicrobial agent. Correct use of antimicrobial agents requires that prescriptions are reviewed on a regular basis to ensure that the selection of the agent is still appropriate, continuation of therapy is still necessary and the route is still appropriate. There have been incidences where patients have had unnecessary long and excessive treatment with antimicrobial agents as a result of therapy not being reviewed. This can impact on so many things such as;

- increased risk of development of resistance organisms
- antibiotic treatment related illnesses
- increased risk of adverse effects
- increased expenditure

The indication of stop date, or intended duration of treatment, on the medicine chart every time an order for an antimicrobial agent is made has worked successfully in many hospitals (St. George's Healthcare Antimicrobial Policy, 2008). The indication for an antimicrobial agent is often not clear and easy to find in the notes and makes monitoring for appropriateness difficult. It would be very beneficial to have the

indication written on the medicine chart for all orders of antimicrobial agents. Worldwide, antimicrobial management is now a key component of infection prevention and control, and prudent antimicrobial prescribing is important in reducing the prevalence of resistant microbes.

Antimicrobials prescribed empirically in life-threatening situations should be reviewed early in the light of microbiological results, clinical progress etc and where necessary changed or discontinued as soon as it is reasonable (Klopotowska et. al., 2010).

Apart from hospital antimicrobial formulary, our prescribers require guidelines for antimicrobial prescribing which should specify recommended agents, dose, route and duration of antimicrobial treatment for major categories of infections.

Dosing errors

Dosage errors ranked next in our study either under dose, majorly involving the antibacterial agents, Amoxiclav and Augmentin (brands of amoxicillin/clavulanic acid tablets) or overdose involving the use of the antibacterial drug, ceftriazone intravenously (IV). The BNF recommended dose of IV ceftriazone as 20-50mg/kg/day in mild infection and up to 80mg/kg/day in severe infection was usually exceeded. Questionnaires filled by the junior doctors in this study also alluded to dosing errors as the most common lapse. In a study involving nine hospitals in Northwest England, the researchers (Seden et. al., 2013) reported that majority of potentially lethal errors were dosing errors, mostly related to overdose. Other researchers have reported dosage errors as the most common type of medication prescribing errors detected (Lesar et. al., 1997; Oshikoya and Ojo, 2007; Lewis et. al., 2009; Weingart et. al., 2010). The pervasive nature of this fault underscores the need for continuing professional education directed at both new and more experienced prescribers.

Use of Abbreviations

Unsafe abbreviations noted in this study related to the prescribing of insulin and some IV fluids. Commonly observed in the prescribing of insulin was the use of ‘IU’ often

used as abbreviation for 'international units' or units. This has a great propensity for mistake in reading or interpretation and errors involving insulin use have been responsible for a disproportionate number of serious adverse events in diabetic patients. A number of specific prescribing errors relating to the use of insulin have been reported in literature. This includes misinterpretation of units written (e.g. 7IU misinterpreted as 70Units) resulting in a 10-fold error of dose; ignorance in use of insulin syringe resulting in ten times overdose; poor handwriting in prescribing insulin leading to ten times units of dose being given instead of a single digit dose for instance 40 units given instead of 4U. The US Institute of Safe Medication Practices (2002) for this reason determined insulin to be a high-alert medication, defined as a drug that has the highest risk of causing patient injury when misused.

Other studies (Cox and Ferner, 2009) have expressed concern over the use of abbreviations in medication prescribing as this tended to cause errors and mistakes. It was therefore advised that the specific word 'unit' be used when prescribing insulin and that the use of dangerous abbreviations should be avoided. Education and training directed at these prescribers may reduce prescribing errors related to insulin use.

Other cases of unsafe abbreviation were writing prescriptions for IV Ringer's lactate solution as IVF RL or R/L, half-strength Darrow's solution as ½ DS and full strength Darrow's solution as DFS (or FSD).The failure of a small number of prescribers to give a fluid name is serious as it could be argued that a ward with regular personnel including nurses, nursing attendants, doctors and others know what is correct practice and what is meant by an abbreviation. But this may not always apply as staff change duties and new staff or staffs from other wards are used. If a word or abbreviation is misinterpreted, a serious incident can occur. Examples of these errors are given in Appendix E.

5.2 Clinical severity of errors

Clinically serious errors assessed in this study included prescribing drugs that could result in potentially serious interactions, instances of miscalculation of doses of drugs especially antibacterials, incorrect frequency of administration of medicines leading to under dose for the condition being treated and not adjusting doses of prescribed drugs for patients whose conditions require such, for example, in severe renal impairment.

In addition, prescribing medicines that were inappropriate for a patient's medical condition was noted in the three hospitals (Tables 4.9b, 4.10b, 4.11b). Some of the errors noted suggested that prescribers tended not to crosscheck their prescriptions, and demonstrated an absence of self-awareness of errors. This collaborated with the findings in the second stage of this study, that our prescribers showed an absence of self-awareness of errors.

Franklin et. al. (2011), in a three-centered study conducted by a validated method on a scale of 0 (no clinical consequence) to 10 (would result in death) assessed a mean score of 5.3 with little variation between the hospitals. Exactly 19.0% of total errors was determined as 'serious'. This was higher than what was obtained in this study but there are subtle methodological differences.

To stop errors from causing harm to patients, pharmacy service should facilitate proactive use of pharmacists to provide advice and clarification at the point of prescribing or as soon as possible afterwards, rather than retrospectively.

5.3 Point of errors in the prescribing process

It was noted that the point of patients' discharge from hospital was the time when the proportion of prescribing errors was highest. Whilst the overall prevalence of errors was disturbingly high in the hospitals, this was even higher for discharge prescriptions (Tables 4.9a, 4.10a, 4.11a). It is of concern that writing discharge prescriptions, tasks based mainly on transcription, were associated with such rates. Though both nurses and doctors are important components in the care of hospitalized patients, pharmacists can play a crucial role in the protection against errors at the point of discharge. At this stage in the prescribing process, the commonest errors noted were the omission of duration of use for take-home medicines. This lapse can mislead discharged patients with chronic illnesses such as hypertension, diabetes or tuberculosis to believe that the absence of a set time for duration of prescribed medicines meant that they are free to discontinue their medications at will. Even though not intended, this lapse may result in treatment failure and further harm to both the patient and public.

Ambiguous orders were also common in discharge prescriptions. This is the writing of an order without specifying the actual name, dose and frequency of the medication. For example, some prescribers write 'haematinics' on discharge orders without

specifying the intended drug, for instance if Tabs. ferrous sulfate 200mg tds or Tabs. folic acid 5mg was desired. These practices should be discouraged and guidelines for proper prescribing of discharge medications be adopted. It was noted that the junior medical doctors, particularly the house officers, were responsible for the majority of prescribing for in-patients at the point of discharge and may have been largely responsible for most of these error.

Other studies identified highest error rates during the in-patient stay when new medicines were written (Dean et. al., 2002), or at point of admission to the hospital (Lewis et. al., 2009).

5.4 Mean error rate per prescriber category

This study initially attempted to measure in retrospect, the mean error rate of in-patient prescribing by category of prescriber but it proved unfeasible to identify many of the prescribers from their signatures. However, the prospective study (Tables 4.21, 4.22 and 4.23) provided some insight into this. Doctors of all grades made prescribing errors although junior doctors especially House officers were responsible for writing most drug orders in the in-patient setting. House officers had the highest error rates in all three hospitals followed by the registrars. This finding was consistent with other studies which reported that junior doctors made more errors than other prescribers (Dean et. al., 2002b; Mandal and Fraser, 2005; Tobaiqy et. al., 2007; Lewis et. al., 2009; Ross et. al., 2012 and Bertels et. al., 2013).

If education is to be a means of reducing errors, it must include the specialist training and continuing professional development of all grades of doctors. It should however be noted that medical officers generated the least prescriptions as they are mostly involved in patient care at the point of admission into the hospital. The prescribers that prospectively wrote some drug orders were not identifiable from their signatures (Tables 4.21, 4.22 and 4.23).

5.5 Medications associated with prescribing errors

Prescriptions involving fluids and electrolyte imbalance (ORS) and antibacterials both oral and parenteral produced the bulk of errant out-patient prescriptions for NHA and UATH while for UCH, they were medicines for the cardiovascular system, anti-

inflammatory and anti-allergic eye drops. However in the in-patient setting, antibacterials and intravenous medicines for fluid and electrolyte replacement ranked highest in the three hospitals. This finding was consistent with findings in a systematic review by Lewis et. al. (2009) and other reported studies (Condren et. al., 2010 and Ghaleb et. al., 2010).

The most common lapse with these agents was the omission of duration of therapy when initiating antimicrobials and omission to give full details of IV fluid rate and duration when ordering them. Antimicrobial prescribing should include essential information on dose, route and duration of therapy as well as the appropriate selection of the antimicrobial agent. Worldwide, antimicrobial management is now a key component of infection prevention and control, and prudent antimicrobial prescribing is important in reducing the prevalence of resistant microbes.

5.6 Relationship between length of hospitalisation and error incidence

This study found that there was a significant relationship between the duration of ward stay and incidence of prescribing errors in the three hospitals. There was a significant difference between the incidences of errors at the first two weeks of ward stay and longer (Figure 4.1).This is likely because more prescriptions were ordered for patients at those initial days of hospitalisation as that was when the condition of many were acute or critical, then when that initial period of critical care was over and the patient's condition stabilized, less medication orders were made until patient's discharged. Usually, at a patient's discharge, medications are ordered but not always.

The implication of this for pharmacists is that more attention and care should be given to medication orders generated on the wards during the first 2-weeks of patients' hospitalization as this is when majority of errors are likely to occur. Pharmacists timely intervention in response to these errors will help mitigate the long-term health effects on patients.

5.7 Causes and factors underlying prescribing errors

Although prescribers must be held responsible for their actions, this study suggests that errors arise as a combination of environment, team, individual, task and latent factors in a system where defences are feeble. This finding was consistent with the

results of others (Sanghera et. al. (2007); Franklin et. al. (2011); Beckett et. al. (2012); Ross et. al. (2013)) and a systematic review into the causes of prescribing errors (Tully et. al., 2009). There is need for better training and education for junior physicians, especially House Officers. Training should include how to write prescriptions correctly with all pertinent information such as the drug name, strength, dose, frequency, duration and direction of use specified and to identify when dose adjustment might be needed. This is a requirement stated in the Nigeria Standard Treatment Guideline and as basic as this might appear, this generally acceptable standard practice is not being strictly adhered to. Safe prescribing skills and an awareness of medication errors is required by all members of the health care team. This should be a central in component of undergraduate and post-graduate programs.

A change of culture is also needed in the way teams communicate treatments. Identifying a drug to be prescribed should go beyond just naming the drug, but should be followed by details about the dose, form, route of administration, duration etc. Prescription- writing should be acknowledged as an important high-risk activity requiring attentiveness and caution. House officers need to have the skills, aptitude and freedom to confirm and clarify directions.

Prescribing of medications for patients with complex problems was noted to be left to inexperienced junior doctors, usually House Officers, who were, on occasions, stressed, distracted or rushed. Team factors, in particular were also more frequently associated with prescribing errors. Since a key focus of the internship year is to produce competent independent medical personnel through an apprenticeship, then supervised training should be a priority (Coombes et. al., 2008). Our findings showed that prescriptions written by House Officers were not always checked by their seniors, a finding reported also by some UK researchers (Dean et. al., 2002a) which indicated that junior doctors felt supervision was inadequate. It can be overwhelming for these inexperienced doctors to have the in-depth pharmacologic knowledge required to treat patients along with identifying and preventing the opportunities for drug-drug interactions, drug- disease incompatibilities and allergies (Brennan et. al., 2011). Supervision must also include a culture in which prescribing errors identified are constructively discussed, analysed and learnt from on the individual, team and organization level (Dean, 2002).

Reference books and guidelines need to be readily available to prescribers. In many cases these essential drug information materials are absent and prescribers have to depend on their personal copies or look for other ways to get the required information. The risk of errors will remain unless institutions make concerted efforts to ensure the availability of protocols, guidelines and formularies in the prescribing environment. Similarly, the environment in which doctors prescribe must not be distracting. Also medication charts should ideally be located at the patients' bedside. Modifying workload is a challenge for all health care professionals and measures to improve staffing levels and reduce stress need to be considered. However doctors could improve their own defenses by recognizing conditions in which they might make an error such as having a heavy workload or feeling stressed. They should therefore be on guard and take extra care to mitigate the effect of these error-prone risks.

5.8 Pharmacists and Nurses as defences or 'safety nets'

In hospitals, pharmacists play a role in the defences against prescribing errors when they screen and validate prescriptions. However this role is mainly limited to within the pharmacy department and during the process of dispensing or filling of prescriptions. Generally, pharmacists are yet to be integrated as vital members of the continuum of health care delivery at the ward level as the practice of clinical pharmacy is not fully incorporated in Nigerian hospitals and its impact amongst prescribers is still modest. Where clinical pharmacy is practiced pharmacists play an important role in identifying and monitoring errors. Nursing staff could also play a crucial defence by reviewing medications before administering. Some of the House Officers interviewed welcomed nurses' intervention in preventing some errors from reaching the patients. Others have also identified the roles of Pharmacists and Nurses as sources of defence (Sanghera et. al. (2007); Franklin et. al. (2011); Beckett et. al. (2012); Seden et. al. (2013).

5.9 Are newly qualified doctors adequately trained for safe prescribing?

It should be expected that errors are associated with prescribing. Prescribing is a multifarious task that requires diagnostic skills, knowledge of medicines, communication skills, understanding of the principles of clinical pharmacology, recognition of risks and additionally, experience. It is an anomaly that the hospital

doctors who have the least experience are those who prescribe the most. From this study, many of the House officers interviewed reported not to have had prior training in prescription writing during their undergraduate curriculum, and rarely a chance to practice prescribing. Even after graduation and absorption into the hospital system for the mandatory medical internship training, many still express concern about the training they receive on the job, and wished for more to achieve the competencies needed for prescribing.

A study, commissioned by the UK General Medical Council on the preparedness to practice of new doctors graduating from three medical schools, examined the full range of competencies expected of newly qualified doctors, and picked out prescribing as the most significant weakness. The study included a prescribing assessment for the graduates of three medical schools and noted that over 80% of the new doctors failed it (Illing et. al., 2008). Findings of the project indicate that undergraduates' preparedness to begin the Foundation Programme (Housemanship) is improved by increased experiential learning in clinical practice as part of their undergraduate programme. Review of these events suggests that failures in education and training are a factor. The researchers concluded that:

> There was a consistent thread, from primary sample data throughout the year, and from triangulation data, of under-preparedness for prescribing. Weaknesses were identified both in the pharmacological knowledge underpinning prescribing, and the practical elements of calculating dosage, writing up scripts, drug sheets, etc. While there was some feeling from triangulating data that F1s were prepared for prescribing, pharmacists did identify severe gaps. Prescribing was also the main area of practice in which errors were reported by respondents, indicating a significant potential risk. Risks were reduced, but not removed, by support from colleagues, with F1s speaking particularly highly about the help received from pharmacists… (Illing et. al., 2008 p.iii).

This should give some concern to the educators in the Nigeria medical schools on the extent to which different medical schools prepare their graduates for the workplace.

5.10 Prospective study to determine the impact of intervention.

The 12-month prospective study showed that at baseline, prescribing error rates at NHA was lower than at the other two sites (Tables 4.24, 4.25, 4.26 and Figure 4.5). Despite this, there was a similarity in the trend of error types. Omitting to write a stop date for ordered medicines ranked highest followed by incidences where drugs which could interact adversely were administered concurrently. Inappropriate dosing errors of under/overdose and use of unsafe abbreviations in writing medication orders were also common. This trend in error types was reproduced in the other two sites, suggesting that an appropriate intervention, directed at correcting this, would translate to an effective comparison of any improvement in the quality of prescriptions afterward.

Potential factors identified from interviews with prescribers as risk for error causation included a lack of awareness of making prescribing errors. Prescriptions were usually written quickly and hampered by interruptions, with junior doctors hardly having time to crosscheck their prescriptions before returning to uncompleted tasks. Consequently, an audit and feedback process combined with educational outreach was employed as interventions to improve the prescribing outcomes. The process was undertaken in small groups with the doctors of the different specialties, at different days apart from the opportunity for correction and education provided by the one-on-one interviews with prescribers who wrote errant prescriptions.

Statistically significant improvement in the writing of prescriptions was observed for NHA prescribers specifically in areas of writing route of administration of drugs ordered, writing non-ambiguous orders, checking for drug interactions and appropriate dosing of medicines (Table 4.18). However, when compared to the results obtained from the control sites, there appears to be some confounding factors affecting the interpretation (Tables 4.19 and 4.20). For instance, statistically significant reduction in prescribing error rates was observed for registrars in both the control and intervention hospitals during the study period (Tables 4.21, 4.22 and 4.23).

House officers and Registrars were responsible for writing the bulk of in-patient prescriptions as revealed in this study. The intervention had minimal impact on the

prescribing error rates of House officers in NHA, as a result of their high turn-over at ward levels due to their intra-specialty rotations, quarterly inter-specialty rotations and bi-annual turn-over in the hospital. As the study progressed it was noted that House officers who received the audit and feedback on their prescribing at a particular clinical specialty were afterward, rotated to other units outside the study wards making it impossible to follow-up on their subsequent prescribing while new House officers reported at the study wards. This was a major drawback as it was not possible to control these established processes. Researchers such as Bowers et. al. (2009) and Bertels et. al. (2013) demonstrated the effectiveness of intervention methods incorporating audit and education when the prescribing environment such as the prescribers and wards were well-controlled.

Overall, there was a modest reduction of some prescribing error types. Results from this study lends support to the notion that the effectiveness of audit and feedback in improving prescribing is enhanced when it is provided more than once, is delivered both in verbal and written formats and includes an action plan or explicit targets (Ostini et. al., 2009; Ivers et. al., 2012).

5.11 Pharmacists role in reducing prescribing errors.

Most studies about reducing errors after prescriptions have been written have been undertaken in hospitals, particularly in the USA. The most common interventions related to specific roles focusing on pharmacists.

Pharmacist roles to identify prescribing errors and to stop them reaching patients include:

- checking for errors as prescriptions are received at the pharmacy and contacting prescribers for clarification or amendment before filling prescriptions
- visiting wards to review charts and provide advice to prescribers about individual patients
- reconciling the medicines patients usually take with what they are prescribed in hospital
- providing medication reviews and counseling upon discharge.

Pharmacists have also run one-to-one or group education sessions for prescribers to provide guidance and training on good quality and acceptable prescription writing.

Limitations:

This study had some limitations: These included the difficulties in identifying and approaching all doctors who had made an error. Secondly, it was at times difficult to conduct interviews within the stipulated 72 hour timeframe of the error occurring. Furthermore, the relatively small size of interviewees was reflective of the proportion of House officers in the units studied. The prescribers who made the errors were presenting their own account to the researcher. It is well recognized that perceived causes reported might be subject to bias, minimising prescribers own responsibilities and emphasizing situational factors so one cannot establish causality with certainty. It is likely that responses offered expressed some measure of social desirability. Also, most of the interviewees were junior doctors, and there was a possibility that the more senior doctors might have provided additional or different perspectives. Nonetheless, from the factors identified as perceived causes of prescribing errors, given its concurrence with other published work, this should be generalisable.

Variations in the definition of prescribing errors between studies published in literature may affect the interpretation of this study as there were no previous local studies to compare the error rates determined in this study. It is important to be cautious about the generalisability of the results as these might have been affected by confounding factors: for instance, the study hospitals might have unique features, differences in individual prescribers' practice or the study period may have been exceptional. Further work is needed to compare different specialties, hospitals and geographic regions for a true picture to emerge. In addressing the potential clinical significance of prescribing errors in the retrospective aspect of this study, there needs to be agreement over definitions of serious and less serious errors. It was possible that this study underestimated this category. However, we believe the study is representative and has raised some key issues for future interventions

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This study has established the feasibility of conducting a review of medical and prescription records for evaluating prescribing errors in hospitals in Nigeria. Medication orders for both out- and in- patients were reviewed, and the data collected from three tertiary hospitals are reported. All medication prescribing errors were assessed, and compared with the requirements of the 2008 Nigeria Standard Treatment Guideline.

Prescription writing by doctors was less than satisfactory: several details that are required for identifying patients as well as prescribers were absent. All grades of prescribers were susceptible to making these prescription lapses and errors and thus are an important target for improvement.

This study determined an in-patient prescribing error rate of 28.7% for UATH, 26.3% for NHA and 41.0% for UCH prescribers. However, only a fraction of these errors were judged to be clinically serious.

Antibacterials and parenteral and oral fluids for electrolyte imbalance were the therapeutic categories most commonly associated with prescribing errors in this study while incomplete prescribing information was the most frequent lapse.

The time of discharge was associated with the highest error rate even though this was the point at which the lowest number of prescriptions were written and ordered.

This study highlighted the applicability of the Reason's human error theory in identifying causes of prescribing errors in a Nigeria tertiary hospital setting.

Prescribing errors occurred from factors in the work environment, team, task, individual and patient levels. Prescribing skills must be expanded through training and by bringing the details of the process and outcome of prescribing into the open, so that errors are discussed and reflected upon, with opportunity for prescribers to learn from their own errors, without fear of reprisal.

A change in culture in which prescribing is seen as important is required with more consistent supervision of junior doctors in an atmosphere that encourages learning and clarification.

Pharmacist-led intervention incorporating educational outreach and feedback produced some success in reducing some types of prescribing errors however this should be a continuous process.

Improvement in prescription writing will improve the efficiency of institutional health care delivery resulting in pharmacists, nurses and other clinicians being able to do their job quickly, with more appropriate use of drugs and less time spent sorting out problems. Patients will ultimately benefit from this.

Samples of prescriptions for the retrospective part of this study were drawn from the year 2010 only (being the year preceding the commencement of this research) because for prescribing indicators, individual health providers tend to exhibit consistent practices over time, so that a sample drawn at one point in time will basically provide the same result as a sample that covers a longer period (WHO, 1993).

6.2 Recommendations

1. Drug prescription orders should be complete. Prescribers need to pay attention to the need for a drug, choose the dose appropriately and include all pertinent information such as patient name, age and gender; generic drug name, dosage form, dose, strength, quantity, route, frequency and duration of administration. Prescribers should also review their orders for correctness and legibility immediately after they have prescribed them.

2. Prescribers should appraise the patient's total status and review all existing drug therapy before prescribing new or additional medications to ascertain possible drug interactions.
3. When writing medication orders, prescribers should use standard nomenclature, using the drug's generic / official or brand name especially if a specific product is required. They should spell out the word "units" (e.g. 20 units of soluble insulin) rather than writing "U" or "IU" which could be misinterpreted.
4. Regular teaching sessions are needed as a tool to help familiarize new prescribers with the format of drug charts, prescription forms, and medication regimens and factors commonly associated with errors. Educational outreach strategies can also be combined.
5. Feedback on prescribing errors is essential to improve current practice. This should be provided to all prescribers on a regular basis as a continually evolving process with emphasis shifted from individual staff and on contributing factors. This should be followed up by an 'Action Plan' with explicit targets set so as to enhance the effectiveness
6. Improvement or change in format of prescription forms and drug chart in some hospitals is recommended so as to accommodate all necessary points of patient information needed such as patient sex, weight, prescriber identification such as doctor's name / identity code and required duration of ordered medicine.
7. Hospitals should have antimicrobial formulary and guidelines for antimicrobial treatment. The guidelines should be evidence-based and reflect nationally agreed practice, and should specify recommended agents, dose, route and duration of treatment. Reference books, protocols and local hospital formulary should be available and accessible.
8. Involvement of clinical pharmacists at all points of the medication process is recommended. Their fundamental role in providing pharmaceutical care functions at the ward level and in participating in medical rounds where their responsibilities in evaluating, detecting and monitoring prescriptions will yield great impact and also provide additional defences against prescribing errors.

6.3 Contribution to knowledge

1. This study has provided information on the common types, nature and rates of prescribing errors in tertiary hospitals in Nigeria.
2. No previous published study on prescribing error rates, and clinical significance of medication prescribing errors in the in-patient setting in Nigeria. The few published studies have focused on the out-patient setting and no known work evaluating the clinical severity of errors.
3. This is the first known study to have applied the Reason's accident causation model in exploring the causes of prescribing errors in the Nigerian setting. Furthermore, it provided an array of factors underlying errors in medication prescribing based on empirical data collected.
4. This is the first known study applying a pharmacist-led educational outreach visit and feedback as intervention in reducing prescribing errors in selected specialties in tertiary hospitals in Nigeria.
5. This study has highlighted the need to review the format of prescription forms and drug chart used in some hospitals, so as to accommodate all necessary points of patient details. Flawed prescription forms provide latent and error provoking conditions in the workplace and can create weaknesses or long-standing holes in the defences designed against errors.

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APPENDICES

Appendix A: Events that constitute a Prescribing Error

Errors in Decision Making

1. Prescription inappropriate for the patient concerned

- Prescribing a drug for a patient for whom, as a result of a co-existing clinical condition, that drug is contraindicated e.g. metformin for a patient with CrCl< 60mL/min; Beta adrenergic -blocker to asthma patients.
- Prescribing a drug to which the patient has a documented clinically significant allergy e.g amoxiclav for a patient with penicillin allergy
- Prescribing a drug and not taking into account a potentially significant drug-interaction e.g Concomitant administration of artemether/lumefantrine and azithromycin (a macrolide antibiotic) => Q-wave elongation, a hazardous interaction; Warfarin + diclofenac (NSAIDs) => increased risk of bleeding.
- Prescribing a drug in a dose which is inappropriate for the patient's renal function e.g clarithromycin, imipenem, ceftazidime- dose reduction required in renal impairment
- Prescribing a drug in a dose below that recommended for the patient's clinical condition e.g. amoxiclav 625mg b.d instead of 8 hourly in respiratory tract infections (RTI).
- Prescribing a drug with a narrow therapeutic index, in a dose predicted to give serum levels significantly above the desired therapeutic range e.g. theophylline: plasma –theophylline concentration for optimum response is 10-20mg/L

- Prescribing 2 drugs for the same indication when only one drug is necessary e.g. amoxicillin and cefuroxime concurrently for RTI when one would be adequate

- Prescribing a drug for which there is no indication for that patient e.g. antibiotics for viral infections

- Not altering the dose following steady state serum levels significantly outside the therapeutic range e.g. digoxin dose should state concentration has been reached

- Continuing a drug in the event of a clinically significant ADR e.g. statins and muscle effects

2. Pharmaceutical Issues

- Prescribing a drug to be given by IV infusion in a diluent that is incompatible with the drug prescribed e.g. nitrofrusside injection administered in a plastic IV container
- Prescribing a drug to be infused via an IV peripheral line, in a concentration greater than that recommended for peripheral administration.

Errors In Prescription Writing

1. Failure to communicate essential information

- Prescribing a drug, dose or route that is not that intended
- Prescribing a medicine and omitting the dose, frequency, route or duration of use
- Writing illegibly
- Writing a drug's name using abbreviations or other non-standard nomenclature
- Writing an ambiguous medication order
- Prescribing 'one tablet' of a drug that is available in more than one strength of a tablet

- Omission of the route of administration for a drug that can be given by more than one route
- Prescribing a drug to be given by intermittent IV infusion, without specifying the duration over which it is to be infused
- Omission of prescriber's identity (name / signature)

2. Transcription Errors

- On admission to hospital, unintentionally not prescribing a drug that the patient was taking prior to their admission
- Transcribing a medication order incorrectly when re-writing a patient's drug chart
- Continuing another doctor's prescribing error when writing a patient's drug chart on admission to hospital
- Writing 'milligrams' when 'micrograms' was intended (or vice-versa)
- Writing a prescription for discharge medication that un-intentionally deviates from the medication prescribed on the in-patient drug chart

Situations that may be considered prescribing errors, depending on individual clinical situation

- Prescribing a drug in a dose above the maximum dose recommended in the BNF or other reference book or guideline
- Misspelling a drug name (major misspellings that lead to ambiguity)
- Prescribing a drug that cannot readily be administered using the dosage forms available
- Prescribing a dose regimen (dose/frequency) that is not recommended for the formulation prescribed
- Continuing a prescription for a longer duration that necessary
- Prescribing a drug that should be given at specific times in relation to meals without specifying this information on the prescription
- Unintentionally not prescribing a drug for a clinical condition for which medication is indicated.

Situations that should be excluded as prescribing errors

- Prescribing by brand name (as opposed to generic name)
- Prescribing a drug without informing the patient of its uses and potential side effects
- Prescribing a drug for which there is no evidence of efficacy, because the patient wishes it
- Prescribing a drug not in the hospital formulary
- Prescribing contrary to hospital treatment guidelines
- Prescribing contrary to national treatment guidelines
- Prescribing for an indication that is not a drug's product license

Appendix B: Data Collection Sheet

Patient details

Initials:_____ Sex:_____ Age:___ Hosp. No:_____

Ward:_____

Diagnosis:_____

DOA			
DOD			
Days			

A S D

Part 2: Medications **Total prescribed:_____**

	A S D Dr		A S D Dr

Errors identified A_____ S____ D_____ Total:_____

Description: HO; NYSC; MO; R; SR; Cs	Drug class

Prescriber : Prescribing writing error____Prescribing decision error__

A= At Admission S= During the ward stay D= At discharge

Appendix C: Error Severity Classification Scheme

Potentially lethal error (a)

An error is defined as potentially lethal if it could have one or more of the following consequences:

- The serum level resulting from such a dose is likely to be in the severe toxicity range based on common dosage guidelines, e.g. serum theophylline concentrations greater than 30 micrograms per ml. More than 10 times the dose of chemotherapy agent
- The drug being administered has a high potential to cause cardiopulmonary arrest in the dose ordered.
- The drug being administered has a high potential to cause a life threatening adverse reaction, such as anaphylaxis, in light of the patient's medical history.
- The dose of a potentially lifesaving drug is too low for a patient having the disease being treated
- The dose of a drug with a very low therapeutic index is too high (ten times the normal dose)

Serious error (b)

An error is defined as serious if it could have one or more of the following results:

- The route of drug administration ordered is inappropriate, with the potential of causing the patient to suffer a severe toxic reaction.
- The dose of the drug prescribed is too low for a patient with serious disease who is in acute distress
- The dose of a drug with a low therapeutic index is too high (four to ten times the normal dose)
- The dose of the drug would result in serum drug levels in the toxic range, e.g. theophylline levels 20-30 micrograms per mL.
- The drug orders could exacerbate the patient's condition, e.g. drug-drug interaction or drug-disease interaction.

- The name of the drug is misspelled or illegible creating a risk that the wrong drug might be dispensed including errors in decimal points or units if the error could lead to the dose being given
- High dosage (ten times) normal of a drug without a low therapeutic index

Significant error (a)

An error is defined as significant if it could have one or more of the following results:

- The dose of the drug with low therapeutic index is too high (half – four times the normal dose)
- The dose of the drug is too low for a patient with the condition being treated
- The wrong laboratory studies to monitor a specific side effect of a drug are ordered e.g. CBC and reticulocyte counts are ordered to monitor gentamicin toxicity
- The wrong route of administration for the condition being treated is ordered e.g. the inadvertent change from IV to oral therapy for the treatment of bacterial meningitis.
- Errors ordering fluids are made e.g. specific additives needed for complete therapy are omitted or incompatible fluids are ordered
- Errors of omission whereby patient's regular medication is not prescribed either on admission, during a rewrite and on discharge

Minor error (b,c,d,e)

An error is defined as minor if it could have one or more of the following results:

- Duplicate therapy was prescribed without potential for increased adverse effects
- The wrong route was ordered without potential for toxic reactions or therapeutic failure
- The order lacked specific drug, dose, dosage strength, frequency, route or frequency information
- Illegible, ambiguous or non-standard abbreviations
- An errant order was written that was unlikely to be carried out given the nature of the drug, dosage forms, route ordered, missing information etc

Examples include, simvastatin prescribed in the morning rather than at night. Bisoprolol – two puffs four times a day.

a. Folli, H.L. Poole, R.L. Benitz, W.E. and Russo J.C. 1987. Medication error prevention by clinical pharmacists in two children's hospitals. *Pediatrics* 79.5: 718-722.

b. Lesar, T.S Briceland, L.L. Delcoure, K. Parmalee, J.C. Masta-Gornic, V. and Pohl, H. 1990. Medication prescribing errors in a teaching hospital. *Journal of the American Medical Association* 263.17: 2329-2334.

c. Lesar, T.S. Lomaestro, B.M. and Pohl, H. 1997. Medication-prescribing errors in a teaching hospital. A 9-year experience. *Archives of Internal Medicine* 157.14: 1569-1576.

d Lesar, T.S. Briceland, L. and Stein, D.S. 1997. Factors related to errors in medication prescribing. *Journal of the American Medical Association* 277.4: 312-317.

e. Tully, M.P. Parker, D. Buchan, I. McElduff, P. and Heathfield, H. 2006. Patient safety research programme: medication errors 2: pilot study. Report prepared for the Department of Health.

Appendix D: Interview schedule with prescribers

Background

- The prescribers were asked to give a brief introduction of themselves, medical school attended, how long they had worked at the hospital, how long in post and what specialty.
- Provide a brief description of type of teaching or learning courses that prepared them for prescribing, how this was taught and if they thought this was adequate.

The prescribing errors (areas covered)

- The type of error made
  -dosing error, omission of information, frequency error, drug interactions etc
- The medication involved
- The condition being treated
- The error situation
  - Time of day
  - Type of ward
  - Type of patient
  - How long at the ward
  - A description of what happened
  - Work load
  - Supervision
  - Stage of patient stay
  - The reason for making the error
- Their attitude towards the error
  - Has this happened before?
  - Has this happened since?
  - How does this make you feel?
  - What do you think could have helped to prevent the error?
  - How will this change the way you prescribe?

Closing

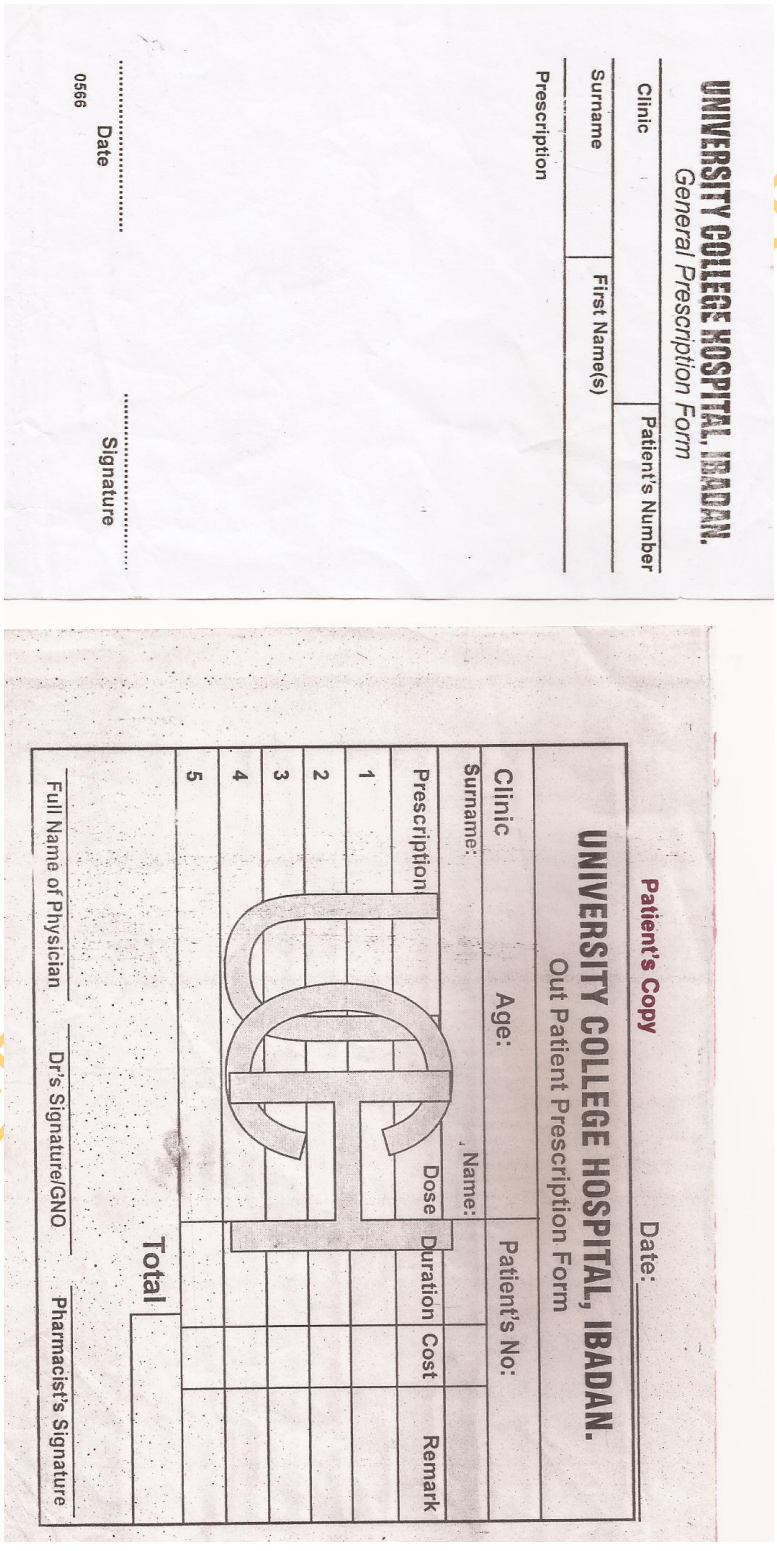
The interviews ended with asking the prescribers if they had any questions, comments or suggestions for the interviewers.

Appendix E: Examples of types of prescribing errors encountered

Ambiguous orders	**Overdose**
-Haematinics -Anti Koch's	IV Ceftriazone 500mg q12 (for a child of 10kg) Cap Tramadol 100mg tds x 5/7
Duration omitted	**Underdose**
- IV Metronidazole 500mg q8h - IV Ceftriazone 1g 12hrly x open	Amoxicillin 250mg bd x 5/7 Tab Amoxiclav 625mg bd x 1/52
Direction of use omitted	**Serious Drug Interaction**
- ORS 3 sachets - Clotrimoxazole cream	Tab Clopidogrel 75mg od + Tab Omeprazole 20mg od Artemether/lumefantrine tabs + Azithromycin tabs
Dose /frequency omitted	**Wrong drug choice**
-P Alaxin 3:3:1 -SC Heparin 5000 IU	Syrup PCM 5mL tds x 5/7 (for an adult patient) Clotrimoxazole pessaries 1nocte x 1/52 (for a male patient)
Unsafe abbreviation	**Drug name omitted**
-Soluble Insulin 8 IU tds -IVF R/L 500mL q 12h - IVF NS ⇔ ½ DFS	Tab 75 mg od x 3/12 Tab Vit 200mg bd x 14/7
Route omitted	**Wrong formulation**
- Frusemide 40mg bd x 5/7 - Insulin 8IU tds	Susp. Ceftriazone 250mg bd x 5/7 Susp. Streptomycin
Inappropriate dosing frequency	**Extended duration**
-Cap Amoxicillin 500mg q6h - Tab Amlodipine 10mg bd	Tab Nitrofurantoin 50mg q6hr x 14/7

Appendix F

Copy of UCH out-patient prescription sheets (seen during the study period). Entry for patient sex was unprovided for.



UNIVERSITY COLLEGE HOSPITAL, IBADAN.
General Prescription Form

Clinic | Patient's Number

Surname | First Name(s)

Prescription

Date

Signature

0566

Patient's Copy

Date:

UNIVERSITY COLLEGE HOSPITAL, IBADAN.
Out Patient Prescription Form

Clinic | Age: | Patient's No:

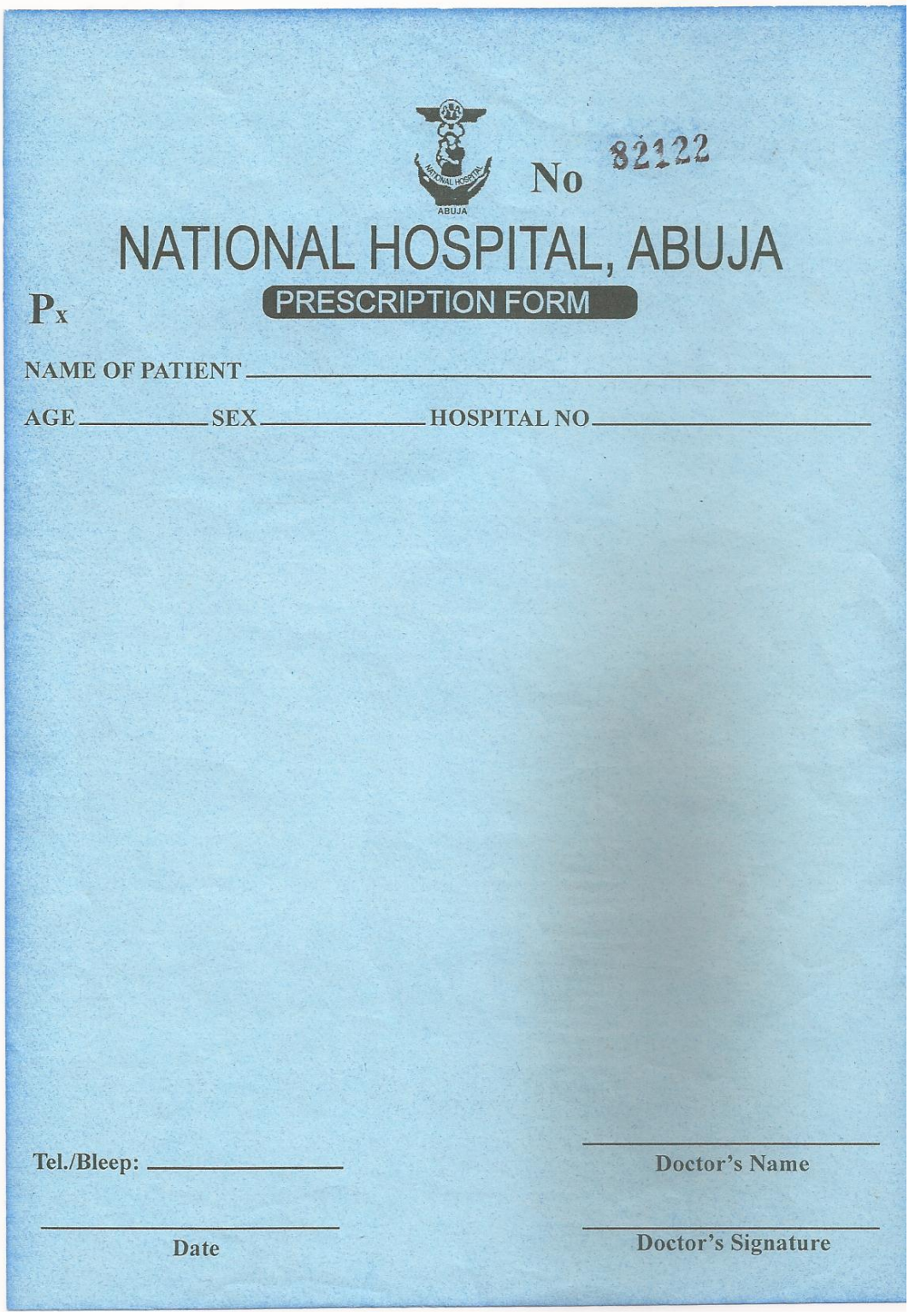
Surname: | Name:

Prescription	Dose	Duration	Cost	Remark
1				
2				
3				
4				
5				
		Total		

Full Name of Physician | Dr's Signature/GNO | Pharmacist's Signature

Appendix G

Copy of NHA out-patient prescription sheet used during the study period



No 82122

NATIONAL HOSPITAL, ABUJA

Px PRESCRIPTION FORM

NAME OF PATIENT _____

AGE _____ SEX _____ HOSPITAL NO _____

Tel./Bleep: _____

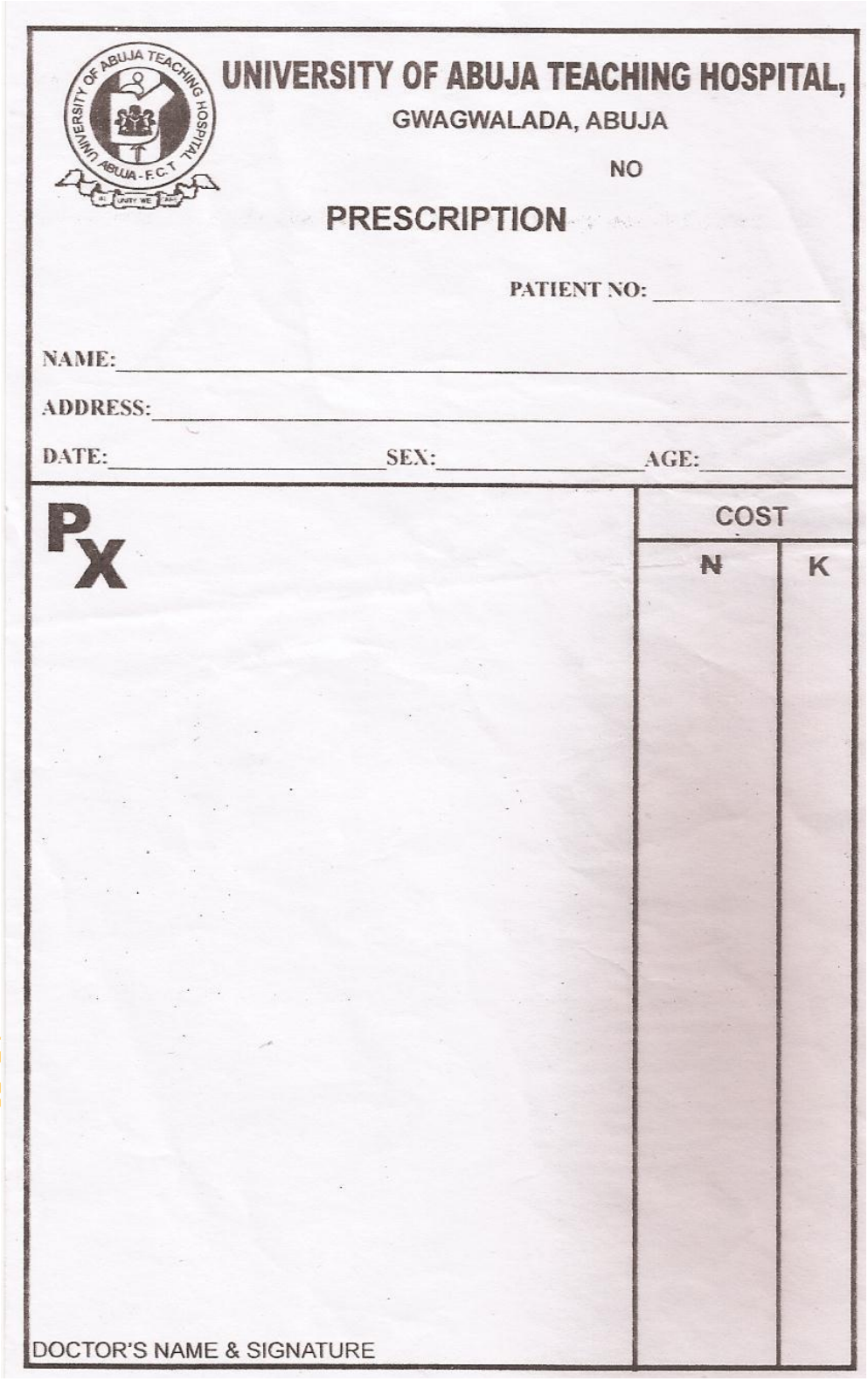
Doctor's Name

Date

Doctor's Signature

Appendix H

Copy of UATH out-patient prescription sheet used during the study period



UNIVERSITY OF ABUJA TEACHING HOSPITAL,

GWAGWALADA, ABUJA

NO

PRESCRIPTION

PATIENT NO: _____

NAME: _____

ADDRESS: _____

DATE: _____ SEX: _____ AGE: _____

Px

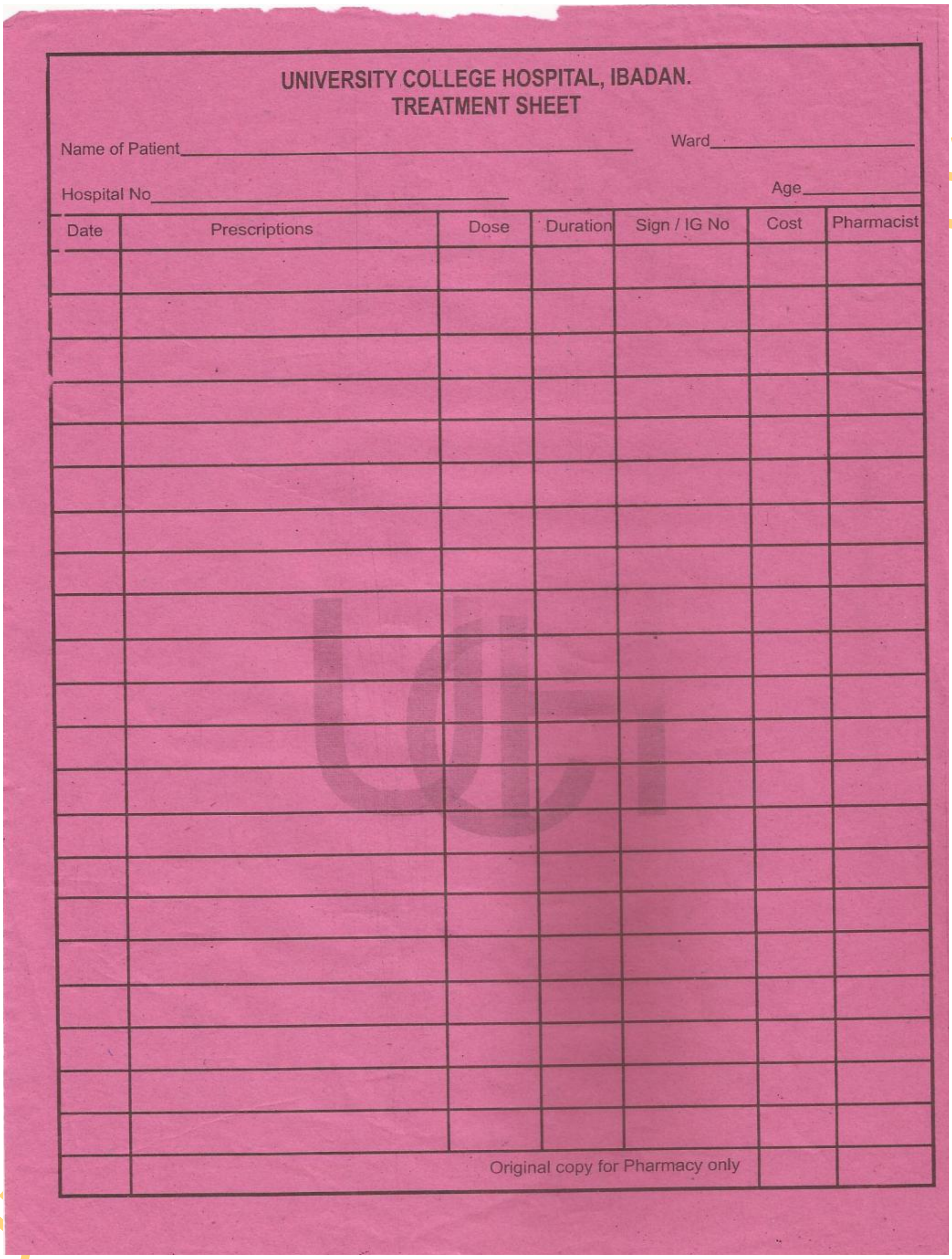
COST

₦ K

DOCTOR'S NAME & SIGNATURE

Appendix I

Copy of UCH In-patient prescription sheet used during the study period.



UNIVERSITY COLLEGE HOSPITAL, IBADAN.
TREATMENT SHEET

Name of Patient ____________ Ward ____________

Hospital No ____________ Age ____________

Date	Prescriptions	Dose	Duration	Sign / IG No	Cost	Pharmacist

Original copy for Pharmacy only

Appendix J:

Copy of NHA in-patient prescription sheet

NATIONAL HOSPITAL, ABUJA

Inpatient Treatment Sheet

page	Surname	Other Names	Age	Ward	Hosp. No

Date	Treatment	N	K

Appendix K

Sample of the questionnaire used in this study.

QUESTIONNAIRE

SECTION ONE

Demographic data: Please tick the appropriate box.

1. **Gender:** ☐ Male ☐ Female

2. **Age (in years):** ☐ Less than 25 ☐ 25-35 ☐ 36-45 ☐ 46-55 ☐ 55-65 ☐ over 65

3. **Education:** ☐ MBBS only ☐ MBBS + Postgraduate degree ☐ MBBS + PG Fellowship ☐ Others

4. **Medical Cadre:** ☐ House Officer ☐ NYSC Doctor ☐ Medical Officer ☐ Resident Doctor ☐ Consultant

5. **Years of Experience as prescriber:** ☐ Less than 1 year ☐ 1-5yrs ☐ 6-10yrs ☐ 10-15yrs ☐ 15-20 yrs ☐ Above 20yrs

6. **Specialty** (Please tick the appropriate column

Obstertrics & Gynaecology	
Medicine / MOPD	
Paediatrics / POPD	
Surgery / SOPD	
Radiotherapy & Oncology	
Ophthamology	
Ear, Nose & Throat	
Dental Surgery	
Radiodiagnosis	
Psychiatry	
Nuclear Medicine	
Family Medicine	
Sexually Transmitted disease Clinic (STC)	
Chemical Pathology	
Intensive Care Unit / Anaesthesia	
Medical Microbiology & Parasitology	
Haematology & Blood transfusion	
Neurosurgery	
Others	

SECTION TWO

1) **How often do you get to prescribe medicines in your hospital practice?**

a) Every day or more ☐ b) 2-6 times a week ☐

c) About once a week ☐ d) About once month ☐

e) Never ☐

2) **Can you remember ever making any prescribing errors?**

a) Yes, very often (> 50%) b) Often (35-50%) c) Sometimes (20-35%)

d) Seldomly (10%-20%) e) Hardly (5-10%) f) Rarely (<5%) g) Never

3) How often has a fellow Doctor or Pharmacist or Nurse called your attention to a prescription written by you?

a) Yes, very often (> 50%) b) Often (35-50%) c) Sometimes (20-35%)

d) Seldomly (10%-20%) e) very seldomly (5-10%) f) Rarely (<5%) g) Never

4) How often have you had to change/alter a prescription as a result of a mistake?

a) Yes, very often (> 50%) b) Often (35-50%) c) Sometimes (20-35%)

d) Seldomly (10%-20%) e) very seldomly (5-10%) f) Rarely (<5%) g) Never

5) A clinically meaningful prescribing error has been defined as '*a prescribing decision or prescription writing process that results in an unintentional, significant reduction in the probability of treatment being timely and effective or increase in the risk of harm when compared with generally accepted practice'*…To what extent do you agree with the above definition.

a) Totally agree b) Partially agree c) Neither agree nor disagree d) Partially disagree e) Totally disagree

6) Where in the patient's stay do you think errors are most likely to occur in your practice environment.

a) ☐ When seeing a new patient

b) ☐ At initial admission

c) ☐ During the in-patient's stay

d) ☐ At discharge (when writing discharge medicines)

e) ☐ During patient history taking.

7) For each of these scenarios, please indicate the extent to which you agree that a prescribing error has occurred:

	Totally agree	**Partially agree**	**Neither agree nor disagree**	**Partially disagree**	**Totally disagree**
Prescribing medicines outside the hospital formulary					
Prescribing medicines by brand name rather than generic.					
Prescribing for a child whose body WEGHT is not documented.					
Prescribing a medication without sufficient education of the patient on its proper uses and effects.					
Prescribing 'one tablet' of a drug that is available in more than one strength					
Failure to adhere to prescribing guidelines					
Omission of the prescriber's signature					
Writing illegibly					
Prescribing a drug not taking account of a potentially significant drug interaction					
Writing a drug's name using a non-standard nomenclature.					
Forgetting to write prescriptions for controlled drugs (CD) in the required manner.					
Omission of the route of admission for a drug that can be given by more than one route.					
Prescribing a drug to which the patient has a documented clinically significant allergy.					

Continuing a prescription for a longer duration than necessary. Prescribing a drug to be infused via an IV peripheral line without indicating frequency or duration					
Prescribing a drug for which there is no evidence of efficacy just because the patient wishes it					
Misspelling a drug name (major misspelling that lead to ambiguity i.e. more than one possible meaning).					
Failure to communicate essential information					
Prescribing a drug that should be given at specific times in relation to meals without specifying this information on the prescription.					
Forgetting to put a stop date on IV infusions					

8) Which of these factors can contribute to the possibility of errors occurring in your practice environment i.e. threats. Tick all appropriate options:

a) Workload ☐ b) Tiredness ☐ c) Busy ☐ d) Multitasking ☐ e) Rushing ☐ f) Distraction ☐ g) No senior support ☐ h) Confused/Nervous. i) low morale

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9) Which of these are the most common reasons for types of mistakes you have encountered or made yourself (circle the appropriate options)

a) Failure to check your prescription with a reference source.

b) Failure to check your prescription with another member of staff.

c) Failure to check if the drug prescribed was contraindicated for his clinical condition.

d) Failure to check if the drug prescribed adversely interacted with another drug the patient is taking.

e) Lack of knowledge of drug indication.
f) Lack of knowledge of drug dose.
g) Lack of knowledge of the different formulation s of drug prescribed.

10) Which of the scenarios listed below is most likely to affect you negatively if you were in the situation.

☐ Unfamiliar pt ☐ Controlled drug prescribing
☐ Late in the day ☐ High work load ☐
Stressed ☐ Understaffing ☐ On call.

11) It is expected that rules for correct prescribing be followed at all times. In a situation where you have to cover a busy ward with little or no support, which of the following are you likely to omit when prescribing for a familiar patient.

a) ☐ check the dose of medicine for his age/weight
b) ☐ check allergy status
c) ☐ check contra-indication to medicines previously prescribed for him
d) ☐ check if drug is in Hospital formulary.
e) ☐ documenting the prescribed drug (s) in the patient's notes

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12) Which of these groups of medicines do you associate with more likelihood of errors when prescribing:

a) ☐ Antibiotics/Anti-microbials
b) ☐ Oncology drugs
c) ☐ Psychiatry medicines
d) ☐ CV drugs and related disease.
e) ☐ Anti infectives e.g anti malarials
f) ☐ Analgesics (opiods and non-op)

13) Most common types of errors you have made if at all: (tick as many)

a) ☐ Dosage errors
b) ☐ Drug-disease interaction errors
c) ☐ Incorrect regimen
d) ☐ omitting duration of drug handwriting
e) ☐ omission of patient's age
☐ Drug-Drug interaction
☐ Duplication of therapy
☐ Incorrect formulation
☐ Poor or illegible
☐ Omission of my signature

14) Having gone through this questionnaire, to what extent do you now agree to having made prescribing errors in the past?

a) Most of the time (> 50%)
b) Often (35%- 50%)
c) Sometimes (20%- 35%)
d) Rarely (<20%)
e) Never (0%)

Thank you very much for your time!

Appendix L

Published work arising from this research project.

1. Ajemigbitse, A.A. Omole, M.K. and Erhun, W.O. 2013
   Medication Prescribing Errors in a Tertiary Hospital in Nigeria: Types, Prevalence and Clinical Significance. *West African Journal of Pharmacy* 24.2: 48-57.

2. Ajemigbitse, A.A. Omole, M.K. and Erhun, W.O. 2011
   An Evaluation of the Types, Prevalence and Severity of Prescribing Errors in National Hospital Abuja. *Archives of Nigerian Medicine and Medical Sciences* 8.1: 22-31.

3. Ajemigbitse, A.A. Omole, M.K. Osi-Ogbu, O.F. and Erhun, W.O. 2013
   A qualitative study of causes of prescribing errors among junior medical doctors in a Nigeria in-patient setting. *Annals of African Medicine* 12.4: 223-231.
   The above work was promoted among Spanish and Portuguese speaking professionals by means of a short communication, CroIn, in Sociedad Iberoamericana de Informacion Cientifica (SIIC)'s official journal and site, http://www.siicsalud.com/tit/crointitulos.php> by the Director editorial, Prof. Rafael Bernal Castro of Ciudad de Buenos Aires, Republic of Argentina.

4. Ajemigbitse, A.A. Omole, M.K. and Erhun W.O. 2013
   An assessment of the rate, types and severity of prescribing errors in a tertiary hospital in southwestern Nigeria. *African Journal of Medicine and Medical Sciences* 42: 339-346.

5. Ajemigbitse, A.A. Omole, M.K. Ezike, N. and Erhun, W.O. 2014
   Assessment of the Knowledge and Attitude of Intern Doctors to Medication Prescribing Errors in a Nigeria Tertiary Hospital. *Journal of Basic and Clinical Pharmacy* 5.1: 7-14.