Prescribing Errors at an Academic Teaching Hospital in Johannesburg

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DECLARATION

I declare that this dissertation is my own unaided work. It is submitted for the degree of Master of Science in Medicine (Pharmacology) at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination in any other University.

Muhammed Vally

This day of _____ October 2017

ABSTRACT

Prescribing errors are considered the most preeminent error in medicine and currently there have been no South African published studies which investigated the occurrence and types of prescribing errors in our hospitals.

Aims

To classify and determine the occurrence of medication prescribing errors in selected ward prescriptions in an academic teaching hospital in Johannesburg. In addition to determine the reasons why these errors occur.

Methods

This study was a mixed methods study that first investigated prescribing error using a retrospective chart review in four wards (medical, surgical, psychiatric and paediatric wards) over a period of two consecutive months. The second part of the study involved using focus groups to determine the systems factors that led to errors taking place in the hospital.

Results

The adult prescribing error percentage was calculated at 17.9% and the paediatric error rate was 31.8%. There was a statistically significant difference in the error rate between the medical ward and others with an error rate of 19.97% in the medical ward, 13.28% in the surgical ward, 17.48% in the psychiatric ward and 31.80% in the paediatric ward. Clear systems factors such as lack of supervision, long working hours, lack of clinical pharmacology training and even lack of prescriber feedback were present that lead to errors taking place.

Conclusions

This was the first study in South Africa to compare four wards and to report on adult and paediatric prescribing errors. There were clear systems factors that could be linked to prescribing errors taking place and recommendations to reduce prescribing errors in the hospital are made.

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LIST OF ABBREVIATIONS

BNF – British National Formulary

CI – Confidence Interval

CRF – Case Report Forms

DOH – Department of Health

F – Females

M – Males

MDT – Multidisciplinary Team

mg – milligram

ml – milliliter

PRN – When necessary

SAMF – South African Medicines Formulary

PRESENTATIONS AND COMMENDATIONS ARISING FROM THIS WORK

Conference Presentations

1. Cross Faculty Symposium 2013. Prescribing Error in Three Adult Awards at an Academic Teaching Hospital in Johannesburg. [Poster]
2. School of Therapeutic Sciences Research Day 2013. Prescribing Error in Three Adult Awards at an Academic Teaching Hospital in Johannesburg. [Podium]
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5. Faculty of Health Sciences Research Day 2014. Prescribing Error in a Paediatric Ward at an academic teaching Hospital in Johannesburg. [Poster]

Awards

1. Awarded the Innovative Pharmaceutical Association Prize for Young Pharmacologist – Best Clinical Presentation at the WCP (World Congress of Basic and Clinical Pharmacology) - 2014
2. Awarded the Best Student Poster Presentation for Clinical Sciences and Therapeutics for Health at Faculty of Health Sciences Research Day in 2014.

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CHAPTER 1: AN INTRODUCTION AND BACKGROUND INTO ERRORS

1.1 Prescribing

Any discussion regarding prescribing error should begin with a discussion of what prescribing is and what the process of prescribing a medicine entails. Prescription and administration of medicines are by far the dominant intervention in the healthcare setting (King *et al.,* 2014). A prescription is considered an instruction that may be written, transmitted verbally or electronically by an authorized prescriber to a dispenser regarding the preparation and use of medicines by a specified patient (Rossiter *et al.,* 2016). Since a prescription is a legal document it must comply with a particular format as set down in the Medicines and Related Substances Control Act (1965). The following information is required on a prescription in order for it to be legal: the name, qualification, practice number, address, contact number(s) of the prescriber; the date on which the prescription is written; the name, address, age, body weight (required in paediatric patients) and the gender of the patient; the approved medicine name, dosage form, strength and quantity of the medicine; instructions prescribing the dose and frequency of administration of the medicine(s); the number and intervals of repeats; the diagnosis or ICD-10 code and the prescribers signature in his or her own handwriting. All hand written prescriptions are required to be neat and legible. It is suggested (though not required) that medicine names be printed in block letters and that decimal points be avoided where they are not necessary. A prescription (under South African Law) is only valid for a period of 30 days from the date it was written. The prescriber is also required to write in his/her own hand the words “no substitution” if he/she does not want the dispenser to substitute the medicine for a generic medicine.

1.2 What is Rational Prescribing?

Rational prescribing is often expected to be derived from some reason or reasoning and be specifically fitted to a particular situation (Aronson, 2009). The main aim of rational prescribing is to make a medicines choice that produces the best clinical outcome while also reducing the potential harm to the patient (Maxwell, 2009). It also aims to prevent wastage of rare and limited healthcare resources while simultaneously taking into consideration the patient's choice of treatment (Maxwell, 2009).

The guide to good prescribing (De Vries *et al.,* 1994) asserts that rational prescribing of a medicine should ascribe to scientific methodology, as when conducting an experiment. The idea being: there must be a definition of the problem, the establishment of a hypothesis, an experiment conducted to test the hypothesis, an outcome and a process of verification. When applying these scientific principles to a patient being treated, the idea is for the prescriber to: identify the patient's problem (i.e. diagnose the patient), specify a therapeutic objective (specific for that patient), choose a treatment (that is proven both in terms of safety and efficacy and is the most appropriate for the diagnosis), then begin the process of treatment and lastly the treatment should be monitored and evaluated for re-adjustment if necessary or stopped if the problem has been solved. The establishment of both the therapeutic objective as well as the correct choice of treatment requires the practitioner involved to have knowledge of clinical pharmacology and therapeutics (Maxwell, 2009).

The process of treatment should be started by writing an accurate prescription and providing a patient with clear information and instructions (Aronson, 2009). However, as Aronson (2009) points out, this is not always the case; even a rational approach to prescribing can result in prescribing that is not correct for that particular situation. Maxwell

(2010) notes that prescribing often does not live up to the idea of being safe, effective, cost effective and centered on the patient.

Maxwell (2009) pointed out that irrational prescribing is a worldwide problem. He has asserted that irrational prescribing includes the likes of poly-pharmacy, the prescribing of drugs that are unnecessarily expensive ,inappropriate use of drugs (such as antibiotics) and the prescribing of drugs with many known drug interactions. These practices have resulted in increased risk of harm to the patient (due to drug-to-drug interactions and serious adverse effects), a decreased chance for the patient to benefit from the medicines that have been prescribed and ultimately low patient compliance (Maxwell, 2009).

1.3 Good Prescribing Practices

When educating prescribers, there are some habits to ensure good prescribing. Some of the important habits include: ensuring a paediatric prescription has the age and weight of the patient, not using a decimal point unnecessarily (15mg rather than 15.0mg), for quantities less than 1g to use a dose in mg as opposed to in grams (300mg as opposed to 0.3g), for quantities less than 1mg using mcg (100mcg instead of 0.1mg) (Rossiter *et al.,* 2016). Furthermore when a decimal point is unavoidable is should be preceded by a zero (0.25mg instead of .25mg). When prescribers wish to express a quantity in litres it is suggested that a "L" be used instead of a "l". When prescribing a medicine to be taken as required, a minimum dose interval should be stated and furthermore directions for use should also be specified. All instructions regarding repeats should be written clearly (Rossiter *et al.,* 2016)

1.4 Errors and Medical Errors

Human error is inevitable (Makary and Daniel, 2016). An error can be defined as a disorder of an intentional act (McDowell *et al.,* 2009). This act is usually broken down into two parts: formulating the action; and executing it. An error in formulating a plan can be considered a mistake. Mistakes tend to occur when people undertake non-routine tasks that require conscious attention i.e. these tasks may require some type of problem solving, judgment, diagnosis, or even the use of theoretical knowledge or the skill set required is outside of the persons previous experience. It is important to note, however, that even routine tasks require cognitive functioning and are still open to error. An error in executing a plan is referred to as a slip/lapse. This is when a person intends to do something correct and inadvertently does something which is incorrect (An example of a lapse may be writing a prescription for *penicillamine* when the intended drug of choice is *penicillin V*) (McDowell *et al.,* 2009).

Medical errors are defined as an unintended act in the medical management of a patient or one that does not achieve its intended outcome. Some other definitions include the failure to achieve the intended aim or a deviation in the process of care that may or may not cause harm to the patient. In a recent analysis, Makary and Daniel (2016) describe medical errors as the third most frequent cause of death in the United States. The authors point out that older data regarding the rate of death due to medical errors were largely outdated and that medical error as a cause of death is often not included in the ranking of causes of death or on the death certificate. Whilst it is impossible to prevent all medical errors, in general, efforts should be made to design better systems to ensure that fewer errors occur, and the consequences of errors, as far as possible, are mitigated. With such a large proportion of

deaths being related to medical errors; these require greater attention and concern. One-sub-type of medical error is medication error (Makary and Daniel, 2016).

1.5 Medication Error

Before defining a medication error, one must start off by understanding what a medication or a medicine actually is. A medication or a medicinal product is defined as a product which contains any compound and excipients which have a proven biological effect, and may also contain excipients only (Aronson, 2009). The Medicine and Related Substances Control Act (1965) provides a more encompassing definition of a medicine. According to the act and its amendments, a medicine is any substance or a mixture of substances that are used or sold for use in the diagnosis, treatment, mitigation, modification or prevention of illnesses. These illnesses can include any disease affecting a person both physically and or mentally. A medicine is also considered a substance or mixture of substances that restores, corrects or modifies any somatic illness, whether they are of psychic or organic origin (Medicine and Related Substances Control Act, 1965).

When one takes into account the definitions of an error and a medication one can now define a medication error as a failure of a treatment or treatment process that could lead to harm or has the potential to harm a patient (Aronson, 2009). The treatment or treatment process in the above definition refers to a medication. Medication error, however, can be broken down into various different categories namely; prescribing error, dispensing error and administration error. Prescribing error consist of errors in prescribing by prescribers, dispensing error contain errors by dispensers during the performance of their duties and administration error are errors committed by staff upon the administration of medicine (Ghaleb *et al.,* 2010). The most prevalent type of error in medicine today is medication error

both in the primary preventative healthcare and secondary healthcare sectors (Barber *et al.,* 2003). Within the ambit of medication error, the most frequent of these errors is prescribing error (Dalmolin *et al.,* 2013). Prescription errors are considered a major problem in the field of medication error (Velo and Minuz, 2009). These errors occur in both general practice and the hospital setting and are usually the cause of preventable harm to the patients.

1.6 Psychological Theories Regarding Medical Error

Some errors tend to be overt and unmistakable like pilot error, as no one can miss a crashing aeroplane and others tend to be small, and would be easily missed if they are not looked for. Not all errors result in lethal consequences, however, highlighting the scale of preventable lethal errors allows for potential improvements in medical practice (Makary and Daniel, 2016). Errors are either acknowledged and corrected or 'covered up'. Applying psychological theories to the handling of errors gives insight into why errors are dealt with in a certain way. The psychologist James Reason (2000) asserts that the way medical error in some circumstances is currently viewed is from an approach called "evaluating the person". This approach is predicated on simply blaming the individual(s) responsible for the error. This, as Reason (2000) suggests, is more emotionally satisfying than blaming the targeted institution. This model has led to professionals 'covering up' for one another so that no one can ultimately be blamed and in no way actually helps the patients or redresses the problem of medical error. Reason (2000) goes on to explain that rather than an individual's responsibility error, is usually a concatenation of circumstances or events i.e. a fault in the system. He further goes on to state that most systems have built-in, layered, safety mechanisms and in an ideal world each of these layers would remain intact. However, in reality these layers are more like layers of Swiss cheese with numerous holes, but unlike

cheese these holes are opening and shutting all the time. In an ideal system each layer would potentially cover up for another layers hole thereby preventing a potential error from happening, however, in a catastrophic error all the holes would be aligned and the error would not be prevented. This idea brings to the fore that there may be system errors, whereby errors may arise from the systems that have the potential to be unsafe. If this is so, it would be valuable to assess the extent of errors, possible reasons and systems that either facilitate or prevent medical error (Reason, 2000). Furthermore, it has also been suggested that a systems orientated approach could increase awareness among healthcare personnel (Velo and Minuz, 2009). Viewing errors from a systems based approach, allows one to design safer systems to either reduce errors or their consequences (Makary and Daniel, 2016).

In order to explore the idea of prescribing error and the systems that contribute to it, this dissertation will proceed as follows:

Chapter 2 will further explore prescribing error, reporting on the incidence and prevalence as described in the literature that is currently available.

Chapter 3 will discuss the aims objectives and methodology of the current study

Chapter 4 will present the results of the quantitative data derived from the prescription of review of patient hospital records

Chapter 5 includes the discussion of the quantitative data derived from the prescription review.

Chapter 6 includes the findings and discussion of the qualitative data that was derived from the focus groups run in the hospital that was part of this project.

Chapter 7 is an integrative chapter which ties together the data from both the qualitative and quantitative arms of the study and synthesizes these into conclusions, limitations and recommendations for future research.

CHAPTER 2: LITERATURE REVIEW

2.1 What Constitutes a Prescribing Error?

Dean and her group (2000) used a Delphi technique to develop a validated healthcare practitioner led-definition of prescribing error. They determined that: "A clinically meaningful prescribing error occurs when, as a result of a prescribing decision or prescription writing process, there is an unintentional significant (1) reduction in the probability of treatment being timely and effective or (2) increase in the risk of harm when compared with generally accepted practices." (Dean *et al.,* 2000; p233).

A two stage Delphi technique involves getting the opinion of a panel of experts. In the particular situation of Dean and her colleague a definition of prescribing error was developed by the researchers in the study and it was then sent out via e-mail to a range of medical, pharmaceutical and nursing practitioners around the United Kingdom for comment. These practitioners were considered the panel of experts. Based on the comment of these professionals the definition of prescribing error was then adjusted and sent out for comment a second time to ensure that everybody felt that the definition represented an accurate viewpoint of what a prescribing error was. This definition has been cited numerous times in many different countries and by many different researchers (Ghaleb *et al.,* 2005; Ghaleb *et al.,* 2010; Coombes *et al.*, 2008; Franklin *et al.,* 2011, Ryan *et al.,* 2014, Lewis *et al.,* 2009; Procyshyn *et al.,* 2010; Ross *et al.,* 2008).

The historical context of how prescribing errors were defined and adjudicated is of vital importance when looking specifically at Dean and her colleague's definition (2000). Prior to their study, the dominant method of describing what a prescribing error was, was through the consensus between the pharmacist and the doctor, who both had to agree that a

prescribing error had taken place (Dean *et al.,* 2000; Folli *et al.,* 1987; Blum *et al.,* 1988; Lesar *et al.,* 1990). This, however, presented a challenge in that it was limited to the knowledge of the practitioners involved in the discussion of the error. Dean *et al.*, (2000) divided prescribing error into three distinct sections, namely: errors in decision making, errors in prescription writing and errors that may or may not apply depending on the situation of the patient.

Dean and her colleagues (2000) Delphi process was the first published attempt to produce a consensus practitioner-led definition that could be used for research purposes and to improve clinical practice. A total of thirteen different error scenarios were found to best describe errors in decision making. Dean and her colleges (2000) then further divided errors in decision making into two separate yet distinct sub-sections. The first of these sub-sections is a prescription that is inappropriate for the patient concerned. A total of eleven scenarios were considered for this subsection. This sub-section contains specific situations such as the prescribing of a drug for a patient who has a clinical condition for which the drug itself in contra-indicated. An example of this type of a situation would be the prescribing of a drug such as atenolol for an asthmatic patient. The second of these subsections deals with the pharmaceutical issues of which an example would be prescribing a drug to be infused via an intravenous peripheral line, in a concentration greater than that recommended for the peripheral administration. A total of two errors fell into this subsection.

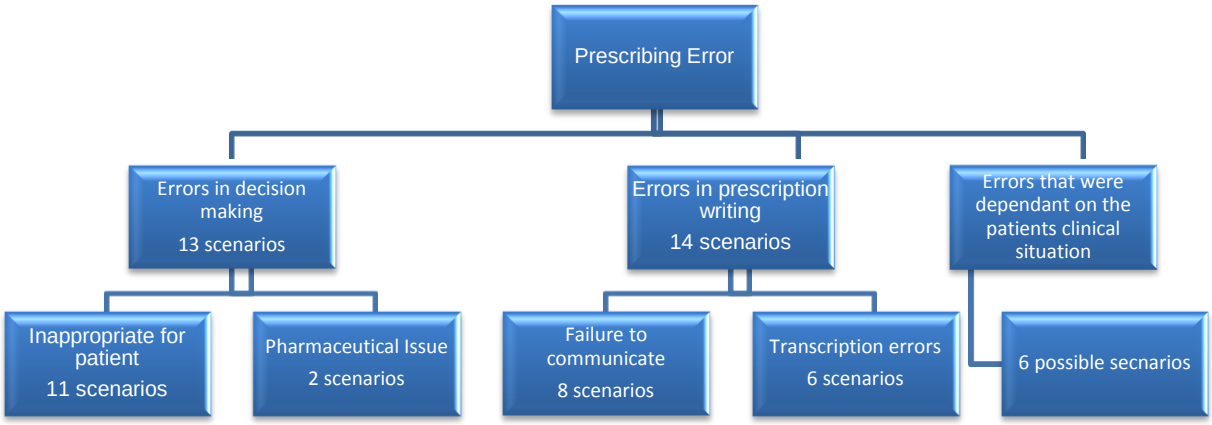

Figure 1: Sub-classification of prescribing errors according to Dean et al (2000)

In addition to this, Dean and her colleagues (2000) then further broke down errors in prescription writing into two separate sub-sections. A total of fourteen scenarios were considered to describe errors in prescription writing. Of these fourteen scenarios that fit into the section of errors in prescription writing, a total of eight of them fit into the sub-section of failure to communicate essential information. An example of a scenario that aptly describes a failure to communicate essential information would be prescribing a dose or route that was unintended (e.g. prescribing 50mg of warfarin when the prescriber intended prescribing 5mg). The second of these sub-sections of errors in prescription writing are transcribing errors. A total of six scenarios were considered by the panel of experts to fit into this sub-section. An example of this type of an error would be writing “milligram” when “micrograms” was intended (e.g. writing a prescription for 50 milligrams of thyroxine sodium when the prescriber intended to write 50 micrograms of thyroxine sodium). Table 1 contains the complete list of scenarios that could be considered as prescribing errors according to Dean and her colleagues (2000).

Table 1: List of scenarios that are considered as prescribing errors by Dean *et al.,* (2000)

Errors in Decision Making
Prescription Inappropriate for patient concerned
Prescribing a drug for a patient for whom, as a result of a co-existing clinical condition, the drug is contra-indicated
Prescription of a drug to which the patient has a documented clinically significant Allergy
Not taking into account a potentially significant drug interaction
Prescribing a drug in a dose that, according to the British National Formulary(BNF), is inappropriate for the patients renal function
Prescription of a drug in a dose below that recommended for a patients clinical condition
Prescribing a drug with a narrow therapeutic index, in a dose predicted to give serum levels significantly above the desired therapeutic range.
Writing a prescription for a drug with a narrow therapeutic range in a dose predicted to keep give serum levels significantly below the desired therapeutic range.
Not altering a dose following steady state levels significantly outside the therapeutic range
Continuing a drug in the event of a clinically significant adverse reaction
Prescribing two drugs for the same indication when only one drug is necessary
Prescribing a drug for which there is no indication in the patient
Pharmaceutical Issues
Prescribing a drug to be given by intravenous infusion in a diluent that is incompatible with the drug prescribed
Prescribing a drug to be infused via an intravenous peripheral line, in a concentration greater than that recommended for the peripheral administration
Errors in prescription writing
Failure to communicate essential information
Prescribing a dose or route that is not intended

Writing illegibly
Writing a drugs name using an abbreviation 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 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 intravenous infusion, without specifying the duration over which it is to be infused
Omission of the prescriber’s signature
Transcription errors
On admission to hospital, unintentionally not prescribing a drug that the patient was taking prior to their admission
Continuing a GP’s prescribing error when writing a patients drug chart on admission to hospital
Transcribing a medication order incorrectly when re-writing a patient’s drug chart
Writing “milligram” when “micrograms” was intended
Writing a prescription for discharge medication that unintentionally deviates from the medication prescribed on the inpatient chart
On admission to hospital, writing a medication order that unintentionally deviates from the patient’s pre-admission prescription

Dean and her colleagues (2000) determined that there was a list of prescribing errors that only applied to certain clinical situations. A total of six scenarios fit aptly into this section. An example of such a situation could be the prescription of a drug in a dose above the maximum recommended dose defined in the British National Formulary (BNF). In scenarios such as these, it is evident that the patient’s status is important as some medical conditions

may require high dose treatment or treatment above the maximum limit for a particular drug (Dean *et al.,* 2000). A complete list of these scenarios is found in the Table 2.

Table 2: List of prescribing errors that may or may not apply depending on the patients' clinical situation (Dean *et al.,* 2000)

Prescribing a drug in a dose above the maximum dose recommended in the BNF or data sheet
Misspelling a drug name
Prescribing a dose regime (dose/frequency) that is not recommended for the formulation prescribed
Continuing a prescription for a longer duration than 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 situation for which the medication is indicated

While these tables clearly document what the research group considered a prescribing error, Dean *et al.*, (2000) also explained the situations that were excluded from their definition of error. A total of seven situations which formed part of the original list of potential errors that were was sent out to the expert panel for comment, were considered by the panel to not be prescribing errors. An example of such a situation would be prescribing a drug by a brand name as opposed to a generic name. Table 3 shows the scenarios that were not considered as errors as defined by this study.

Table 3: Scenarios not considered a prescribing error as defined by Dean *et al.,* (2000)

Prescribing by brand name (as opposed to generic name)
Prescribing a drug without informing the patients of its uses or potential side effects
Prescribing for a child a drug that has no product license for use in children
Prescribing a drug that is not in the hospital formulary
Prescribing contrary to hospital guidelines
Prescribing contrary to national treatment guidelines
Prescribing for an indication that is not a drug's product license

While the above definition is clearly outcome orientated regarding errors, Velo and Minuz (2009) note that it does not take into account the failures that happen during the process of prescribing that are independent of any potential or actual harm to the patient. However, Ross *et al.,* (2008) pointed out the need for a standardized definition for prescribing error, the definition provided by Dean *et al.,* (2000) seems to be the best definition available. To add weight to this argument, Ross *et al.,* (2009) pointed to the fact that this definition describes errors in both the prescription writing process and the decision making process which makes it a good definition as both these elements present a situation in which the patient may possibly be harmed if errors occur.

2.2 Prescribing Error in Paediatrics – Definitions and Scenarios

In defining what constitutes a prescribing error in paediatrics, Ghaleb *et al.,* (2005) used a similar Delphi technique to his mentor, Bryoni Dean, and found that the definition of a prescribing error in paediatrics is essentially the same as the definition in adults that was determined by Dean *et al.,* (2000). Thus the decision was made to use the same definition as proposed by Dean *et al.,* (2000) for both adults and paediatrics. Ghaleb *et al.,* (2005) however did not break down prescribing error into various different sub-sections as Dean *et al*., (2000) did for the adult population (see above for discussion on these subsections). Instead, Ghaleb and his colleagues (2005) combined some of the situations that were considered to be prescribing errors by Dean *et al.,* (2000) as well as some situations that would be specific for paediatric prescriptions into one list of scenarios that the group felt was all encompassing of the possible errors that could potentially take place in the paediatric population. These scenarios were also sent out to the panel of experts for comment and a final list after two stages of comment was compiled. The final list contained a total of twenty seven scenarios that could be considered a prescribing error in the paediatric population. Table 4 summarizes all the scenarios considered to be prescribing errors in paediatrics (Ghaleb *et al.,* 2005).

Table 4: Scenarios that Ghaleb et al., (2005) considered as prescribing errors in paediatrics

Prescribing a drug based on the weight of the patient and not writing the final dose calculated in the prescription sheet based on that weight.
Writing illegibly.
Prescribing a drug to a patient while the patient has a known allergy to that drug.
Prescribing a drug to a child without documenting the weight of the child on the prescription sheet.
Prescribing a drug to a patient without adjusting for renal insufficiency.
Misspelling a drug name.
Prescribing a dose regimen (dose/frequency) that is not that recommended for the formulation prescribed.
Continuing a prescriptions for longer than necessary
Unintentionally not prescribing a drug for a clinical condition for which medication is indicated
Prescribing a drug that should be given at a specific time in relation to meals without specifying this information on the prescription
Prescribing a drug given by intermittent intravenous infusion without specifying the duration over which the infusion must take place
Prescribing a drug with a narrow therapeutic index in a dose predicted to give serum levels above the desired therapeutic range
Writing an ambiguous drug order
Prescribing a drug given by intermittent intravenous infusion in a diluent that is incompatible with the drug that is prescribed.
Writing a prescription for a drug with a narrow therapeutic index in a dose predicted to give serum levels below the therapeutic range.
Omission of the prescribers signature
Prescribing a drug without taking into account a potentially significant drug interaction
Continuing a drug in the event of a clinically significant adverse drug reaction
Prescription of a drug in a potentially sub-therapeutic dose
Writing a drugs name using abbreviations or non-standard nomenclature
Prescribing a drug for a patient who has a specific contra-indication to its use

Prescribing a drug to a patient without adjusting for body size
Prescribing to a patient a dose that is not within the ±25% of the recommended dose
Prescribing a dose that is calculated on an out of date body weight
Prescribing a drug to a patient without adjusting for age
Prescribing a drug to be taken when required, without specifying the maximum daily dose of the drug prescribed in the participant
Not re-writing a prescription in full if a change has to be made to it (e.g. dosage increase or change in frequency)

2.3 Severity of Errors

Seventy five percent (75%) of all studies in the field of prescribing error (by 2009) had attempted to class errors in terms of their severity. Most of the studies used their own method to determine prescribing error severity, however, there have been a few published methods describing how best to decide on the severity of a prescribing error (Lewis *et al.,* 2009). One of the reasons for these varying methods of deciding on severity of prescribing errors is that each study used different criteria. Some methods were based on process indicators while others on patient outcome. A few methods were based on potential outcomes to the patient and some methods used a combination of these (Dean *et al.,* 1999). Methods based on process indicators would consider the pharmacological category of the drug involved in the error. The problem with such methods is that while they are simple and reliable, their validity cannot be assessed. Methods based on patient outcomes, may have a high validity rate, but are not always applicable to every patient. Therefore a patient outcome of harm in one patient may not produce the same harm in another patient or group of patients. It is clear therefore that a scale based on *potential* outcomes is more advantageous, as it does not depend on the actual outcome. The disadvantage of such a

method, however is that it relies on the knowledge of the people making the judgements and is therefore highly subjective. It was these inherent problems with all these system that lead the search for a more reliable system. A validated method for scoring the severity of medication errors was published in 1999. In it, the authors canvassed thirty professionals from four United Kingdom hospitals and asked them to rate fifty potential medication errors on a scale of zero to ten (Dean *et al.,* 1999). The idea here was that a score of zero would indicate an error with no potential effect on a patient while a score of ten would indicate a situation that would result in the death of a patient (Dean *et al.,* 1999). The professionals chosen were asked to volunteer from different hospitals. The final panel of professionals or judges consisted of thirty people. Ten of them were pharmacists, ten were nurses and ten were physicians. A brief summary describing the fifty medication errors were sent to each of the practitioners and there were asked to rate the severity using a visual analogue scale. It was found that using the most reliable method would be to use four healthcare practitioners and ask them to rate the severity on visual analogue scale and thereafter this mean score should be considered the score of the severity of the error. The study also found that if any four judges pooled from the population of experienced pharmacists, nurses and medical practitioners were asked to score a potential error using this system, their mean score for the error was generalizable to any other four judges in the same population. There is acknowledgement from the authors that while they used a visual analogue scale in their study, any measure of risk must take into account the probability and the extent of harm to the patient (Dean *et al.,* 1999).

As Garfield *et al.,* (2013) point out, assessing the severity of prescribing errors and indeed medication errors increases their clinical relevance. It is therefore paramount to assess their

severity and an appropriate method of assessing severity should be chosen. The method chosen to the assess severity must meet the criteria of being reliable and valid. One statistic that Garfield and her colleagues (2013) highlight is that 44% of prescribing error studies measuring the prevalence of prescribing errors in secondary care did not asses the severity of the errors. Garfield and her colleagues (2013) proposed that when studying the prevalence of prescribing errors, an assessment must be made of the severity of these errors at the same time. Garfield *et al.,* (2013) also points out, the method described by Dean *et al.,* (1999) is one of only seventeen methods that have a measure of reliability, but its rigorous methodology makes it extremely time consuming and therefore it is not frequently used. The methodology is one of only five methods which also have a measure of validity. Since the above two criteria i.e. validity and reliability are met, this methodology described by Dean *et al.,* (1999) can be considered rigorous.

2.4 Quantitative Determination of Prescribing Errors

Lewis *et al.,* (2009) found that there was a lack of standardizations between studies, especially regarding their definitions and data collection methods, and these were barriers to understanding the extent of prescribing errors and were an area that that needed to be developed in future. The study also highlighted the difficulty in standardizing the severity of prescribing errors as some studies did not distinguish between prescribing error or dispensing or administration errors while others provided their own classification of prescribing error severity which therefore made it impossible to compare severity across all the studies.

2.4.1 Importance of Methodological Differences

Variability of the methodologies used to determine the prescribing errors can result in different in different recorded rates (Ferner, 2009; Franklin *et al.,* 2009; Lewis *et al.,* 2009; Davis, 2011). There are essentially four different methodologies that have been used to detect and quantify prescribing errors. The first method is by prospective screening of ward prescriptions by the pharmacists who work on the wards, but this can lead to an underestimation of prescribing error rates as ward pharmacists are liable to correct erroneous information without informing the doctor or noting the error on the patients chart (Davis, 2011; Dean *et al.,* 2002). The second methodology is a retrospective analysis of patient records and is considered to be the methodology which is associated with the highest prescribing error percentage (Franklin *et al.,* 20009; Ferner, 2009; Davis 2011; Lewis *et al.,* 2009). This methodology, however, is vulnerable to incomplete patient records and is limited by its inability to provide patient follow up (Lewis et al., 2009). The third and fourth methods used in data collection for prescribing error studies include spontaneous reporting by ward team members and retrospective use of trigger tools. Both of these methodologies are known to be the least accurate and are subject to underestimating the prescribing error rates. With these differences in the methodologies, it becomes difficult to be able to accurately and fully compare different studies to one another.

The definitions used to describe prescribing errors are equally important here. Some studies in the past have chosen to use their own definitions which best suited their needs or the needs of the wards in which the data itself was collected (Lewis *et al.,* 2009). While others chosen to go with Dean *et al.,* (2000) practitioner lead definition of prescribing error. With such differences there are variabilities in the results that these studies produce and subsequently it becomes difficult to compare these studies directly (Lewis *et al.,* 2009).

Equally difference in how the numerators and denominators are determined for the prescribing error studies can cause variabilities in the results that different studies produce. Different denominators can result in either the underestimation of prescribing errors or the overestimation of prescribing errors (Franklin *et al.,* 2009). When studies estimate the denominator based on an estimated number of prescriptions written this can result in an underestimation of prescribing errors. In contrast to this when studies use the number of erroneous prescriptions as the denominator this can result in an overestimation of the prescribing error rate. Thus, knowing and understanding the numerators and denominators of each study along with their definitions and scenarios allows one to make an accurate judgment of the strength of the study but also allows one to understand which studies can be compared to one another with great accuracy.

2.4.2 Prescribing Errors Rate from Prospective Studies

Previous studies in the United States showed that medication error killed almost seven thousand people annually and accounts for 1 in 20 of all admissions into hospital (Barber *et al.,* 2003; Dean *et al.,* 2002; Kohl *et al.,* 1999). In the United Kingdom researchers had originally established that 1.5% of prescriptions have some type of a prescribing error (Dean *et al.,* 2002; Barber *et al.,* 2003). One has to bear in mind that the study conducted by Dean *et al.,* (2002) was conducted in just one hospital in the United Kingdom and was also the first study to use the practitioner-led definitions described by Dean *et al.,* (2000). Other researchers from the United States suggested that the prescribing error rate there was about 6.5% (Lesar *et al.,* 1997; Bobb *et al.,* 2004). All these studies we prospective analysis of patient records and thus are subject to potential under reporting with regards to the prescribing error rates (Dean *et al.,* 2002; Barber *et al.,* 2003). Subsequent to these studies Franklin and colleagues (2007) in a prospective interventional study noted the 462 errors

occurred in 4995 prescriptions with an estimated prescribing error percentage of 9.2%. This study was limited by the number of days over which the data was collected (8 days) and thus may not have given an accurate picture of the true percentage prescribing error rates. Lewis *et al.,* (2009) noted in their systematic review of prescribing error data from around the word, that a prescribing error occurred in a median of 7 in every 100 prescriptions, thus giving the indication that the prescribing error percentage was approximately 7%. In their comment on this review Franklin *et al.,* (2010) noted that the median prescribing error percentage was probably was probably 9.9% and ranged between 7.7-14.6%. Franklin and colleagues noted that Lewis *et al.,* (2009) had neglected certain studies in their systematic review which probably resulted in their underestimation of the prescribing error percentage. A study conducted by Franklin *et al.,* (2011) noted that the prescribing error in the adult population in a prospective multi-centre and multi-ward study may have been as high as 14.7% (95% CI 13.8%-15.6%). This study utilized the definitions that were derived by Dean *et al.,* (2000) and also that medical admission wards were subjected to higher prescribing errors rates (16.3%) when compared to surgical wards (12.2%). Subsequent studies by Ryan *et al.,* (2014); Seden *et al.,* (2013) and Ashcroft *et al.,* (2015) have all revealed different prescribing error percentages. Ashcroft *et al.,* (2015) noted that mean error rate as 8.8%, while Ryan et al., (2014) noted the rate as 7.5% and Seden et al., (2013) noted that 43.8% of all prescriptions written during the study period contained one prescribing error. The studies by Ryan *et al.,* (2014) and Seden *et al.,* (2013) have focused on multiple hospitals and multiple wards and thus the data from these studies maybe more robust and a more accurate reflection of the picture regarding the prescribing error rates in the United Kingdom.

2.4.3 Percentage Prescribing Error Rates in Retrospective Analyses

While all the studies mentioned above were prospective analyses of medication orders (i.e. prescriptions), a retrospective study from the University of Washington over a 5 month period in an internal medicine department found that at least 28% of prescriptions had at least one error in them (Devine *et al.,* 2007). The study looked at 1411 prescriptions from this ward. All the data came from handwritten prescriptions. Of this only 0.2% of errors were considered to cause serious harm to patients. Errors were broken down into two types, namely: clinical and non-clinical errors. Clinical errors consisted of errors in drug-drug interactions and prescribing drugs that were contraindicated for use by the patient concerned, while non-clinical errors were errors such as wrong dose, missing information, illegibility of prescriptions etc. The study found that only one patient was harmed by these errors (Devine *et al.,* 2007). Another retrospective study that was conducted in Ni *et al.,* (2002) examined primary outpatient department prescriptions. The percentage prescribing error described in this study was also higher than the median number reported by Lewis *et al.,* (2009) and Franklin *et al.,* (2010). These studies along with the numerous others that were presented by Lewis *et al.,* (2009); Franklin *et al.,* (2009) and Davis (2011) illustrates that retrospective analyses of patient records produce higher prescribing error percentages than their prospective counterparts.

2.4.4 Studies Assessing Types of Prescribing Errors

In studies by Dean *et al.,* (2002); Franklin *et al.,* (2007); Barber *et al.,* (2003) dosing errors were the most frequently reported errors in prescribing in the adult population. Subsequent studies by Franklin *et al.,* (2011); Seden *et al.,* (2013); Ashcroft *et al.,* (2015) and Ryan *et al.,* (2014) all noted that medication omissions from prescriptions were the cause of the most prescribing errors in their respective studies.

When examining each of these studies in a bit more detail Dean *et al.,* (2002) noted that 54% of all errors found in their study were dosing related and the rates of error also varied depending on what stage the patient was in their hospital stay. There was a higher incidence of prescribing error during the patients in-patient stay, than during either admission or discharge (Dean *et al.,* 2002; Barber *et al.,* 2003).

In the 2007 study by Franklin *et al.,* In order to achieve this, ward pharmacists, each fortnight, were instructed to record data on any prescribing errors that they identified on newly prescribed medicines, when medicines and discharge medications were required. This took place over a four month period in one major clinical district in the United Kingdom, comprising of two large hospitals. The data was collected on four alternate Wednesdays and then four alternate Mondays. All errors relating to a previous error were excluded from their study. Neither patient's names nor hospital numbers were recorded in the study. In order for the pharmacists to be capable of undertaking the study they were given a verbal briefing as to how to collect the data. The idea was to use the errors found on these prescriptions to write up a written summary of the errors occurring the wards at these hospitals. These summaries would then be given to the clinicians on the ward as a form of feedback. The finalized report would have concise but relevant information that the

prescribers could use to change their behaviour in a non-punitive manner (Franklin *et al.,* 2007). An interesting point of the study was that of all the prescriptions collected the ward pharmacists, and the same pharmacists noted that they would only have reported 19 out of the 474 errors that were detected. The framework of the data collection also meant that they only included three types of prescriptions i.e. new medication orders, when required medication orders, and discharge medication orders. They did not focus on once off medication orders and IV infusions. One of the key pieces of information brought out in their discussion is the possibility that different specialties may have different error rate. Some of the errors they found ranged from not indicating the duration of antibiotics for discharged patients, to incorrectly prescribing the frequency of antibiotics, to using too high a dose of antacids (e.g. sodium algenate at 70mls qds instead of 20mls qds) to ambiguously written prescriptions (e.g. omeprazole 40mg IV daily was prescribed but on the prescription form it was circled as to be given twice daily). Other errors included sub-therapeutic doses of medications such as intending to prescribe paracetamol 1g IV and instead writing a prescription for paracetamol 1mg IV. There were instances where patients were prescribed 2 different ACE inhibitors (which would be considered unnecessary given that they have the same mechanism of action) and patients being prescribed two different formulations that had the same combination of a long acting beta -2-agonist and corticosteroids i.e. they were prescribed Seretide and Symbicord (Franklin *et al.,* 2007).

The study by Franklin *et al.,* (2011) was the first study of its kind to compare two of the same type of wards in three different hospitals in the United Kingdom. This study utilized the definitions and scenarios that were designed by Dean *et al.,* (2000). This was clearly accounted for, however by the fact that there was more prescribing taking place in the

medical ward as opposed to the surgical ward. The most frequently occurring errors found in the medical ward were omission of important prescription information (7.5% of all errors), incomplete prescriptions (2% of all errors) and inappropriate doses (3.8% of all errors). The most frequently occurring errors found in the surgical wards included inappropriate doses (3.7% of all errors), incomplete prescriptions (~2.2% of all errors) and omission of important prescription information (~2.5% of all errors).

The study was designed so that a pharmacist could try and intervene should an error be occurring and the intervention came mostly within a mean 0.9 doses being administered. There were 522 cases in which the pharmacist corrected error before any dose of drugs were administered to patients. In the remaining 382 cases, at least one or two doses of the drug were administered before the pharmacist could correct the problem. Overall in this study, a pharmacist intervention resulted in a correction of 69.4% of all the errors reported. There were very few errors recorded as a result of illegible prescriptions, patients being allergic to the drug prescribed or a completely wrong choice of drugs. The study was, however, limited to pharmacists working in these hospitals looking at the prescriptions, and therefore could have been subjected to under reporting (Franklin *et al.,* 2011).

Ryan *et al.,* (2014) attempted to quantify the amount of prescribing errors that were committed by junior doctors as these are the doctors who most often prescribe medicines in secondary care facilities such as hospitals. The study was both teaching hospitals and district general hospitals in Scotland. The study also used Dean *et al.,* (2000) definition for prescribing errors. The highest number of errors came from medication omission (963 errors), followed by incomplete prescriptions (527 errors) and lastly by dosing errors (434 errors). The incorrect total daily dose accounted for 238 of the errors while medicines

prescribed without an indication (238 errors), duplication errors (154 errors) and inappropriate abbreviations (148 errors) were also prevalent. Incorrect timing on prescriptions along with omissions of prescribers signature were less frequent, but the least frequently occurring types of errors reported in this study were: drug prescribed for the wrong patient (16 errors), and prescription of medicine that the patient is allergic to (16 errors). Ryan and colleagues (2014) also noted that prescribing errors occurred more frequently on patient admission rather than on patient discharge. This was despite the doctors reporting insufficient time to write discharge prescriptions.

The studies by both Ryan *et al.,* (2014) and Franklin *et al.,* (2011) both noted that that designated teaching hospitals were far more likely to have prescribing errors than the standard district hospitals. Furthermore, both Ryan *et al.,* (2014) and Franklin *et al.,* (2011) noted that there was a statistically significant difference between the number of errors in a medical ward and a surgical ward. Ryan *et al.,* (2014) also noted that errors were more likely in mixed-wards, surgical ward or other wards when compared to the medical ward.

The study by Ni *et al.,* (2002) broke down their types/scenarios of prescribing errors into categories. Of the total 862 prescribed items, 2 did not have approved drugs while 690 (80%) did not have the route of administration, 485 (56.3%) did not have a strength, 314 (36.4%) did not have a dosage form and 46 (5.3%) lacked a frequency at which the drugs should be administered. It is important to note that all prescription errors noted for their lack of dosage form were only considered an error if the drug itself was available in multiple dosage forms. Most of the drugs that did not have an indication were eye drops and other external preparations. The authors suggest that perhaps the prescribers thought that the pharmacists would fill in a standardized set of instructions for the patient. The authors also

noted that were a total of 39 drug-drug interactions (4.5%) and 27 wrong dosage forms. With regards to the drug-drug interactions, the team noted that only 15 of them could be considered potentially hazardous and that most of them could be overcome if the patients were carefully monitored. With regards to wrong dosage forms, often patients were meant to be prescribed sustained released dosage forms and instead were prescribed the standard dosage form of the drug. This resulted in the standard dosage forms of medication prescribed being dispensed to the patient and the patient not receiving the adequate dose for an optimal therapeutic outcome.

2.4.5 Studies Assessing Legibility and Prescription Completeness

In South Africa and most of the world, both the process of prescribing and documenting medicine administration is a handwritten process. This means that the misspelling of the drug, the illegibility of prescriptions and use of abbreviations by prescribers needs to be minimized in order to prevent prescribing and indeed medication errors (Brits *et al.,* 2017).

Studies have focused on looking at the legibility and the completeness of written prescriptions (Calligaris *et al.,* 2009; Albarrak *et al.,* 2014; Brits *et al.,* 2017). In these studies a point that was raised about by all these authors was the increased risk of harm that patients faced when prescriptions with either incomplete or illegible. Prior studies which noted the level of legibility varied between 20-64% of all written prescriptions (Calligaris *et al.,* 2009). Calligaris and colleagues (2009) noted the level of incomplete written prescriptions in both medical and surgical wards to be around 29%, while Albarrak *et al.,* (2014) noted that 19% of prescriptions were incomplete in a study that took place in Riyadh. Calligaris *et al.,* (2009) noted that 25% of antibiotic prescriptions were either incomplete or illegible and up to 50% of the prescriptions that they review lacked both the date and

signature of the prescriber who had written the prescription. Brits *et al.,* (2017) noted in a South African Hospital that 35% of prescribers could not be identified from the prescriptions that they had written and this made it difficult for a pharmacist would could not read or found an error on the prescriptions they had written to contact them. These are the dangerous of not being able to note who the prescriber of a particular medication is.

Calligaris *et al.,* (2009) noted that 20% of prescriptions did not comply with writing the frequency of administration over which the antibiotics should have been given, while 23.3% of prescriptions did not have the dose of the antibiotic that should have been administered. The research team also found that only 13% of prescriptions for antibiotics did not have a route of administration, making it one of the factors that the team looked at which was complied with often. When looking broader at the context throughout the hospital the research team was able to determine that 23.9% of prescriptions that were written were illegible while 29.9% of prescriptions were incomplete (Calligaris *et al.,* 2009).

A concept mentioned by both Calligaris *et al.,* (2009) and Albarrak *et al.,* (2014) was the level of the pharmacists who were doing the assessments of the prescriptions. Albarrak *et al.,* (2014) and Brits *et al.,* (2017) noted that more experienced pharmacists were more likely to be able to read illegible prescriptions and Brits *et al.,* (2017) showed that pharmacists in South Africa who were completing their community service were less likely to be able to read illegible prescriptions than either doctors or nurses. Calligaris *et al.,* (2009) further noted that electronic prescribing or computerized prescribing would probably reduce the number of errors as a result of incomplete prescriptions, and Albarrak *et al.,* (2014) proved this point by noting that computerized prescriptions were less likely to be incomplete. Albarrak *et al.,* (2014) also noted that surgical departments or wards were less

likely to have incomplete prescriptions than primary care clinics. Other noteworthy findings from the study by Albarrak *et al.,* (2014) included: 12.1% of the handwritten prescriptions had no dose for the drugs that were being prescribed and 15.1% of handwritten prescriptions were missing a route of administration.

2.4.6 Studies Examining Prescribing Errors with Particular Drug Classes

Some prescribing error studies looked specifically at errors occurring within one particular class of drugs or one particular condition. An example of one such study was the study conducted by Zaidi *et al.,* (2015). The study conducted in Liverpool in the United Kingdom looked specifically at quantifying and reducing the number of prescription errors related to inhalers prescribed for patients who had asthma or COPD in a secondary care setting. The study had three phases: the research team looked at prescriptions written for inhalers and examined whether these were correct. Incorrect prescriptions were classified as those where the wrong device, strength or drug or any combination of these were prescribed to a patient. The second phase looked at the knowledge that foundation level doctors had regarding prescribing of inhalers in patients with asthma and COPD. The final phase of the study looked at providing flash cards to foundation level prescribers along with other educational interventions such as lunch time talks to educate these prescribers on how to correctly write prescriptions for inhaler devices. After the intervention, Zaidi *et al.,* (2015) then looked at another sample of inhaler prescriptions to determine whether their intervention had reduced the number of prescribing errors. Overall the prescription error rate with regards to inhaler prescribing was 14%, and the errors included prescribing the incorrect strength of the drug, the incorrect device or the incorrect drug for the patient concerned. The authors found prescribing errors on inhaled medications were frequent and were highest in medications that were prescribed in multiple devices and doses. Startlingly

the prescribers noted that very few foundation phase or junior doctors actually knew much about how to prescribe inhalers correctly (which they determined from the quiz they gave to the junior doctors who took part in their study where the average score was 4/26 prior to their intervention and 5/26 after their intervention), nor was the 14% error rate reduced after all of their educational interventions (Zaidi *et al.,* 2015). This study highlights two vital points, firstly that even well thought out and easily accessible educational interventions for junior doctors may not produce reductions in prescribing errors with regards to inhaled medications and also there is a lack of knowledge among junior doctors regarding correctly prescribing inhaled medication (Zaidi *et al.,* 2015).

2.5 Prescribing Errors in Psychiatric Wards

Psychiatric medications are well known to cause adverse events and they can result in drug-related hospital admissions (Procyschyn *et al.,* 2010). The types of these adverse events are related to the nature and combinations of psychiatric medications. Given the nature of nature psychiatric conditions, patients are usually exposed to polypharmacy and often multiple prescribers. Thus the chances of a medication error or an adverse drug reaction are high. With psychiatric prescribing errors there are questions regarding what the numerators and denominators are when calculating the percentage error rate (Procyschyn *et al.,* 2010).

While many studies have looked at medical ward prescribing errors, very few had actually taken a detailed looked at prescribing error in a psychiatric ward (Stubbs *et al.,* 2006). The numerator in general seems to be the number of errors while the denominator most used seems to be the number of prescriptions review by the pharmacist or the number of medication orders written (Procyschyn *et al.,* 2010). In general, many psychiatric studies like

those of Stubbs *et al.,* (2006) and Bowers *et al.,* (2008) have been retrospective there has been a shift to prospective studies as well. With a number of studies like Bowers *et al.,* (2008), Stubbs et al., (2004) the definition for prescribing error proposed by Dean et al., (2000) was adopted. The problem with this definition is that it does not taking into account the complexities of psychiatric patients nor does it take into account the fact that some psychiatric patients may have to be forcibly administered medicines (Procyschyn *et al.,* 2010). The prescribing errors in psychiatry can be broadly classed as either in decision making or errors in prescription writing and thus most errors were either clinical or clerical (Procyschyn *et al.,* 2010).

With these factors in mind, Stubbs and his colleges (2006) decided to do a prescriptions audit of the psychiatric ward in 3 different hospitals in the United Kingdom (two in Northampton and one in London). The aim of the study was to look at the nature, frequency and potential severity of errors during a one week study of a psychiatric ward using a retrospective observational study method. The study employed nine pharmacists who assessed a total of 22036 prescriptions. Working off the definition of prescribing error set down by Dean *et al.,* (2000) and using the scenarios developed by the same study, Stubbs and colleagues (2006) found that a total of 523 errors were found. This equated to a percentage error rate of 2.4% on all prescriptions written. Given that at the time of this study the error rate in the medical wards in the United Kingdom was 1.5% (Barber et al, 2003), it gives the impression that there is a possibility of more prescribing errors occurring in the psychiatric ward as opposed to the medical ward. 77.4% (405) of errors were in prescription writing and 22.6% (118) resulted from errors in decision making. Again emphasizing the point made by Procyschyn *et al.,* (2010) that most errors in psychiatric

were either clerical or clinical. The most frequently occurring errors in prescription writing were incomplete prescriptions (27.5%), no prescriber's signatures (13.0%), prescribing the same drug twice on one prescription chart (5.7%) and prescribing a dose or route that was not intended (4.2%). Of the 22.6% of errors in decision making, 9.8% were from prescribing a dosage regime that was not recommended for the formulation being prescribed. In 280 of the 523 cases the medicine had been administered before the prescribing error had been picked up by the pharmacist. Of interest though is that most errors were of minor importance in terms of severity to the patients but 4.3% of the errors were deemed to have the ability to cause serious harm to the patients. While this number is small, equating to 22 errors, this is still an error of concern as the researchers point out. These 22 errors occurred in 17 patients, leading to the inevitable conclusion at least one or more patients were at the receiving end of one or more serious errors (Stubbs *et al,* 2006).

Similar to the study by Stubb *et al.,* (2006), both Keers *et al.,* (2014) and Bowers *et al.,* (2008) conducted studies investigating prescribing errors in psychiatric wards. Keers and colleagues (2014) examined three inpatient units at NHS hospitals in the United Kingdom and was the first large scale prospective study of its kind while Bowers and colleagues (2008) examined only one inpatient psychiatric ward. Both Bowers *et al.*, (2008) and Keers *et al.,* (2014) used similar methodologies with regards to quantifying prescribing errors but both studies focus on different aspects of prescribing errors.

Keers *et al.,* (2014) investigated prescribing errors and their relation to the experience of the practitioner who committed the errors and used this information to generate odd ratios and correlating multinomial logistic regression values. The study by Keers *et al.,* (2014) used clinical pharmacists to collect prospective data from the three wards. In total the prescribing

error rates noted by Keers and colleagues was 6.3% (95% CI 5.6 to 7.1%) with the highest ward percentage error being 10.7% (95% CI 8.6% to 12.7%). In this study, the vast majority of errors came from omissions of medicines when the patients were admitted to the wards (12.7%) followed by incorrect or missing administration times/frequencies (11.5%), missing strengths or doses (10.4%). Prescribing incorrect formulations followed next and accounted for 9% of all errors while unsigned prescriptions accounted for 8.3% of all errors and missing dates accounted for 7.3% of all errors. It is worth noting here that neither Dean *et al.,* (2000) nor Stubbs *et al.,* (2006) or Bowers *et al.,* (2008) considered not having a date on a prescription as a prescribing error. Underdosing of medicines in the study by Keers *et al.,* (2014) accounted for 6.9% of all errors. It is worth pointing out that this was a prospective analysis of psychiatric patient prescriptions and also investigated how many errors were clinically significant. 56% of all errors were clinically significant with 6.9% of errors being considered serious. Of interest, was where this study findings differed from the norms established by Dornan *et al.,* (2009) in the large EQUIP study. The study noted that contrary to the evidence presented by Dornan *et al.,* (2009) who noted that younger less experienced doctors were more likely to commit prescribing errors, the situation was different in psychiatry. In psychiatry the evidence presented by the odds ratios developed by Keers *et al.,* (2014) showed that specialty trainees in psychiatry and staff grade psychiatrists had higher odds ratios than foundation doctors (interns). These results were statistically significant and correlated well with the multinomial logistic regression that Keers and colleagues (2014) undertook. Thus, in the psychiatric wards, interns or younger doctors may be less likely to commit prescribing errors.

The study by Bowers and colleagues (2008) did however follow the exact methodology of Stubbs *et al.,* (2006) but focused primarily on one general psychiatric ward which housed 24 inpatients. Importantly, while the study utilized the scenarios set down by Dean *et al.,* (2000) as well as the definitions by Dean *et al.,* (2000), it only focused on the 23 classical scenarios that Dean *et al.,* (2000) discussed. It did not investigate the ward for the patient specific clinical situation scenarios that Dean and colleagues (2000) also discussed in their study. Furthermore the authors chose to include intravenous infusion errors as part of their study. Two prescription audits were carried out by Bowers and colleagues (2008) each lasting a total of 6 weeks. The first which took place prior to an intervention plan took place between March and May and the second audit of prescribing took place after the intervention plan was instituted during the months of June to July. This study did not have ethics approval and while it is worth noting the results, one must be weary of that fact. Prior to the intervention during the first audit, the prescribing error percentage was 23%. This was reduced to 11% and this change was noted as statistically significant. The dominant error scenario was a lack of a prescribers signature followed by ambiguous medication orders. Thereafter the prescribing of a drug as “one tablet” when it was available in more than one dose occurred .

The general trend among all these studies seem to be prescription writing which included: illegible prescriptions, ambiguous prescribing, writing incomplete prescriptions, unsigned prescriptions , misspelling of drug names and prescribing drugs with specifying the strength of the medicine (Procyschyn *et al.,* 2010; Stubbs *et al.,* 2006; Bowers *et al.,* 2008; Keers *et al.,* 2014). To reduce these errors education must be continuously given to prescribers regarding the how to write prescriptions. Paton and Gill-Banham (2003) noted that addition

to these errors, drug interactions in psychiatry can have potentially serious outcomes. An example noted by these authors was the co-prescription of NSAIDs and lithium which could lead to lithium toxicity.

2.6 Prescribing Error in the Developing Word

A large amount of literature has been written about medication errors and prescribing errors in the developed nations of the world such as countries in Europe, the United Kingdom and even the United States less has been written about medication errors in South Africa and the developing world.

2.6.1 Prescribing Error Rates in Selected Developing Countries

A study conducted in India by Pote *et al.,* (2007) determined that the prescribing error percentage to be 34% of all prescriptions written. This percentage was lower than the 55.1% reported in Tanzania by Mugoyelo *et al.,* (2008) but higher than the 27.1% reported by Malangu and Nchabeleng (2012). The study by Malangu and Nchabeleng (2012), while conducted in South Africa only on patients taking antiretroviral therapy and it was different from the study by Pote *et al.,* (2007) who performed a prospective study on prescribing errors in a teaching hospital. From these statistics, it can be inferred that prescribing errors occur more frequently in the developing world than the developed world. Part of the reason for these studies having higher prescribing error percentages could be accounted for by the fact that these studies did not use the definition by Dean et al., (2000) and relied on their own definitions.

2.6.2 Types of Prescribing Errors that Occur in the Developing World

Pote *et al.,* (2007) noted that the most frequently occurring prescribing errors in their study was due to drug-drug interactions accounting for 68.2% of all errors. Paul *et al.,* (2015) found something similar and reported that drug-drug interactions accounted for 52.9% of all prescribing errors. This was in contrast to Malangu and Nchabeleng (2012) who noted the most predominant error was the incorrect ARV regimen prescribed for the patients which accounted for 33% of all prescribing errors. Dosing errors noted by Pote *et al.,* (2007) accounted for 9.6% of errors in their teaching hospital. These types of errors were not noted by Paul *et al.,* (2015) but dosing errors were higher in the South African HIV study by Malangu and Nchabeleng (2012). Omissions from prescriptions were similar in both studies by Pote *et al.,* (2007) and Paul *et al.,* (2015). Malangu and Nchabeleng (2012) noted higher rates of omission errors. A general problem noted by both Malangu and Nchabeleng (2012) and Brits *et al.,* (2017) seem to be the large number of incorrectly spelt drugs and incorrect use of abbreviations.

A reason for the large number of drug-drug interactions noted by Pote *et al.,* (2007) was the methodology that was chosen for the study. The data from the prescription was fed into a computer database which was running a drug interaction checker. The drug interaction software that was used could possibly pick up drug interactions that may not have been clinically significant. Based on the statistics mentioned both in this section as well as the previous section, it is easy to conclude that rates of prescription error seem to vary depending on both the type of method used to collect the data as well as the region of the world in which the data was collected (Pote *et al.,* 2007).

2.7 Intervention of the Clinical Pharmacist

Khalili *et al.,* (2011) attempted to determine the role of the clinical pharmacists' intervention in the detection and the prevention of medication errors in a medical ward. This study which took place over a whole year, at various hospitals in Iran found that of the 861 prescriptions that were looked at by various selected clinical pharmacists, 112 of them had errors. It did however find that in up to 14% of cases, the inappropriate drug was prescribed for the clinical condition that was diagnosed. What could be considered even more alarming than even this is that the percentage of errors where drug doses were too high or their dosage regime was not frequent enough (15.2% and 23% respectively). This research, however was limited by both its small number and restrictions in defining medication error. In addition, during this study the medication errors (and prescribing error) were detected in the early phases by the clinical pharmacist and therefore Khalili and his team (2011) could not investigate as to whether medication errors may result in longer hospital stays, a premise described in United States literature. Some of the other ways that clinical pharmacists could benefit patients in wards (besides reducing medication errors) include: reducing the number of adverse drug reactions that patients would experience, improve the appropriateness of prescribing and contribute to reductions in costs to both the patient and the hospital (Bergvist *et al.,* 2009; Hellstrom *et al.,* 2011; Gillespie *et al.,* 2009).

Similar findings were made by Dale *et al.,* (2003) who also noted that clinical pharmacists could help detect prescribing errors on a medical ward in the adult population. The problem seems to come in with psychiatric wards (Procyshyn *et al.,* 2010). In many cases there is a lack of infrastructure for clinical pharmacists in psychiatric wards or hospitals and furthermore there is a general lack of pharmacists to be able to make such interventions a

reality (Procyshyn *et al.,* 2010). Some of the potential interventions that clinical pharmacists could play in psychiatric wards include: (i) discussing and developing protocols for prescribing; (ii) providing medicine related information for prescribers as required; (iii) taking part in ward rounds and identifying adverse drug reactions and interactions (Procyshyn *et al.,* 2010).

In paediatrics, Wong *et al.,* (2009) noted that pharmacists monitoring of prescriptions could result in an avoidance of medication errors by up to 81%. It was also noted that approximately 47% of all errors in paediatrics could be improved by better communication between pharmacists and prescribing physicians.

2.8 Quantitative Determinations of Paediatrics Prescribing Errors

Davis (2011) posits that prescribing errors in the paediatric population are perhaps more important than their adult counterparts.

2.8.1 Important Considerations Regarding Paediatric Prescribing Errors

Paediatric and adults are substantially different from a pharmacological viewpoint (Ghaleb *et al.,* 2010; Levine *et al.,* 2001; Standing *et al.,* 2005). Paediatric patients have different pharmacokinetic, pharmacodynamics and toxicological profiles depending on their ages and stage of development. Thus, in paediatrics the importance of calculating the dose of the medication cannot be understated, something that is not as important in the general adult population (Ghaleb *et al.,* 2010; Levine *et al.,* 2001; Standing *et al.,* 2005). Medicines that are prescribed in paediatrics must have their doses calculated for each individual patient and this leads to an increased opportunity for dosing errors (Wong *et al.,* 2009). Thus, in paediatrics the importance of calculating the dose of the medication cannot be understated,

something that is not as important in the general adult population (Ghaleb *et al.,* 2010; Levine *et al.,* 2001; Standing *et al.,* 2005). Often drugs used in the paediatric population are used off-label leading to unclear guidelines with regards to dosing information (Davis, 2011). Importantly even a small mistake in a dose for a child can have more significant consequences than a small dosing error in an adult (Davis, 2011). Kaushal *et al.,* (2001) and Miller *et al.,* (2007) noted that the paediatric population was at a higher risk of having a medication error when compared to their adult counterparts.

2.8.2 Prescribing Errors Rates in Selected Paediatric Studies

Estimated prescribing errors in the paediatric population by different authors have ranged between 4-30% (Potts *et al.,* 2004; Fontan *et al.,* 2003; Kaushal *et al.,* 2001). These studies were all completed prior to the standardized practitioner-led definitions for paediatric prescribing errors as described by Ghaleb *et al.,* (2005).

In 2010, Ghaleb and colleagues conducting the first multicenter study in the United Kingdom investigated prescribing and dispensing errors in paediatrics. The study was conducted in 11 wards for prescribing errors. These wards were part of a sample taken from 23 hospitals in London comprising of 5 non-teaching hospitals and 18 teaching hospitals. The study was a prospective review of drug charts with ward pharmacists identifying the prescribing errors. Ghaleb et al., (2010) reported that the error rate in paediatric in patients was 13.2% (95% CI 12.0 to 14.5%) on medication orders. This study investigated a total of 444 paediatric patients with 2955 prescriptions that were written across three different paediatric wards with the lowest percentage error recorded being 5% (95%CI 2.2 to 7.8%). In comparison to this study two different intervention studies conducted by Otero *et al.,* (2008) and Davey *et*

al., (2008) noted that prior to their intervention phases the reported prescribing error percentages of 11.4% and 30.5% respectively.

In South Africa, a study by Gokhul *et al.,* (2016) noted the prescribing error percentage as high as 89.2%. The methodology used in this study was asking members of staff in the paediatric ICU to report errors that they noticed which may have been committed by other staff members as well as from independent chart reviews of computerized records of prescribing. The methodology of spontaneous reporting as Ferner (2009) notes has little hope of providing reliable epidemiological data with regards to errors as the people reporting the errors can choose to report different information. The authors themselves note that this method is limited in its application.

2.8.3 Types of Prescribing Errors in Paediatrics

A literature review by Wong *et al.,* (2004) concluded that dosing errors were the most frequently occurring medication error in paediatrics. Eleven of the 16 studies that were reviewed showed that dosing errors were the most frequent (Wong *et al.,* 2004). This was found to be true over a range of methodologies and definitions. Lewis *et al.,* (2009) also reported a similar finding and found that the predominant error in paediatric prescription was dosing related errors. Otero et al., (2008) noted that due to the complexities of calculating doses, this could result in an increased chance of dosing errors being committed by prescribers. Other studies have looked specifically at trying to quantify a particular type of prescribing error which was considered a frequently occurring error in paediatrics. One such study was conducted by Horri *et al.,* (2014) who looked at the frequency of dosing errors in handwritten prescriptions. The study used their own definition of prescribing errors which deviated from the prescribing error definition for paediatrics as defined by

Ghaleb *et al.,* (2005). The population group for the study was preterm infants that were admitted to two different NICU's. The research team found that the written dosing error rate varied between 3.1% and 3.8% between the two wards in question. The team identified 37 dosing errors of which 17 dosing errors were as a result of overdosing and 20 were as a result of underdosing (Horri *et al.,* 2014). Khalili *et al.,* (2011) describes that dosing errors in the paediatric surgical wards may even be as high as 72%. Kidd *et al.,* (2010) also found that junior doctors committed more errors in paediatric prescriptions.

The study conducted by Gokhul *et al.,* (2016) not only examined prescribing errors in a neonatal ICU in Durban but also investigated the ability of doctors and nurses to calculate required doses. The study found that very few professionals were able to calculate either the dose of a medicine required or how much of medicine should be administered to a patient on a standardized 11 question medical calculation questionnaire. Gokhul and colleagues (2016) concluded that with such poor results in the calculations sections meant that medical and allied health professionals lacked knowledge in clinical pharmacology and therapeutics.

Comparatively, Ghaleb *et al.,* (2010) noted that the most frequently occurring error in their study was incomplete prescriptions (41.2% of all errors), followed by incorrect use of abbreviations (24% of all errors), incorrect doses were the third most frequently occurring errors accounting for 11.3% of all errors. The other errors which Ghaleb *et al.,* (2010) also noted were prescribing drugs at their incorrect frequency (6.6%), illegible prescriptions (3.6%), incorrect infusion rates (3.6%), incorrect routes of administration (1.3%) and a category entitled miscellaneous (8.4%). The miscellaneous category housed everything from incorrect spelling to drug interactions and not all the scenarios that were placed under this

category were described in detail. Similarly, in the pre-intervention phase of their study by Otero *et al.,* (2008) noted the most reported errors pre-intervention was omission of time on prescriptions (42%), followed by errors in dosing intervals (22%) and then omissions from the prescriptions (13%). Wrong doses or dosing errors only accounted for 10% of all errors. Again this study was similar to Ghaleb *et al.,* (2010) where dosing errors were not the most frequently occurring errors in either the pre or post intervention phase of the study. Thus both Ghaleb *et al.,* (2010) and Otero *et al.,* (2008) both found that dosing errors were not the dominant prescribing errors in their respective studies.

Another intervention study was carried out by Davey *et al.,* (2008) was located at a district general hospital and was focused on paediatric prescribing errors. Compared to the study by Ghaleb *et al.,* (2010), this study was focused primarily within one hospital within the district of West Yorkshire and was an NHS trust hospital. Davey *et al.,* (2008) noted that 2.4% of all errors were due to overdosing, while 1.2% of errors were due to underdosing of medicines and 0.8% were caused by non-sense doses. Approximately 1.6% of errors had dosing units that were unclear or absent. The use of mg instead of mcg accounted for 0.4% of all errors, thus totaling the dosing related errors to approximately 6.4%. This was, however, lower than the 7.6% of errors relating to absent medication strengths and the 7.2% which were accounted for by the absence of a frequency of administration on PRN (when necessary) dosing. 1.6 % of all errors were noted when the PRN doses exceed the maximum recommended daily dose for the drug and 0.4% if errors were due to missing or incorrect routes of administration Davey *et al.,* (2008). While this was not considered a type of error by Ghaleb *et al.,* (2005), Davey and Colleagues (2008) considered not using blank ink to write a prescription as a form of prescribing error and report on it. The absence of a

signature accounts for 2.8% of all errors and unclear frequency of administration accounted for 1.6% of all errors. This study used pharmacists to deliver tutorials regarding prescribing in paediatrics and the intervention reduced the number of errors by almost half. It also reduced the number of overdosing and underdosing of medicine and well as scenarios like absent medication strengths and absent frequencies for PRN dosing. While Davey and colleagues (2008) noted that none of the errors were clinically significant medication errors, the errors detected could have led to clinically preventable harm and adverse effects for the paediatric patients. This study was limited by its sample size in both the pre and post intervention study, and being conducted in one hospital.

Lastly, Gokhul *et al.,* (2016) noted the most frequently occurring error was the failure to renew a patient's prescriptions (38.7), followed by delays in prescribing medicines (22.5%), then writing the incorrect strength of a medicine that is being prescribed (19.8%) and a duplicating a patients prescription (16.2%).

2.8.4 Examples of Intervention Studies

The study by Davey *et al.,* (2008) used the educational tutorials to junior prescribers to reduce the number of prescribing errors. The prescribing error percentage was 30.5% in the pre-intervention phase and this was reduced to 16.5% post intervention. This meant that there was a reduction in the number of errors which occurred in every 1 in three prescriptions to approximated 1 in 6.1 prescriptions with $p < 0.05$ indicating statistical significance. It is important to note that the pharmacists, who collected this data, were not blinded and this could potentially lead to bias in the study Davey *et al.,* (2008).

The study by Otero *et al.,* (2008) reported a decrease in the prescribing error percentage of 4.1%. The intervention in this study was an educational intervention which looked

specifically at promoting a change in the approach of the ward team members towards medication errors. The team members were given a tool to develop a safety orientated attitude towards prescribing. The programme was spread through grand rounds, Multi-Disciplinary Team (MDT) meetings and even anonymous reporting of errors by those who noticed the error (Otero *et al.,* 2008).

2.9 Causes of Prescribing Errors

While all these statistics paint a picture of the number of prescribing errors being significant, it does not given a clear indication of the reasons as to why these errors are committed. In a qualitative study by Coombes *et al.,* (2008) the question was asked why interns make prescribing errors. The study was conducted among 14 interns who had committed 21 errors and attempted to determine the possible reasons for the interns having committed these errors. All of the 14 interns were subjects to a face to face interview and human-factor analysis. It was found that errors were multi-factorial and a median of 4 different types of performance-influencing factors per error.

Some of the more common factors included high workloads on the interns as well as long working hours, in addition many of them were tired and hungry and some were even distracted (Coombes *et al.,* 2008; Dean *et al.,* 2002a; Leape *et al.,* 1995; Tully *et al.,* 2009; Dornan *et al.,* 2008; Ross *et al.,* 2013;Duncan *et al.,* 2012; Lewis *et al.,* 2009).

In addition to the factors listed above Barber *et al.,* (2003) and Maxwell (2010), noted the lack of teaching therapeutics (i.e. clinical pharmacology) to medical students at a university level. Barber and his colleagues (2003) also noted that prescribing of drugs is predominantly taught to doctors during their pre-registration years in the form of shared knowledge

among peers. This assertion is also mentioned in the guide to good prescribing by de Vries and his colleagues (1994), who go on to further the discussion by pointing out that this type of teaching also opens up newer graduates into the medical profession to the possibility of learning incorrect prescribing habits from their more experienced peers. It also means that the possibility of these graduates (when they are more experienced) passing on these habits to graduates who come after them. This creates a cycle of 'bad' prescribing. Dornan and colleagues (2009) as well as Duncan *et al.,* (2012) also noted that some medical graduates felt that they were only taught pharmacology and they were not taught prescribing. To them the pharmacology did not help with prescribing but only helped them to have a little bit of knowledge about drugs (Dornan *et al.,* 2009; Duncan *et al.,* 2012; Franklin et al., 2011). Pharmacology as one student noted was more science based and not prescribing based.

Other noted factors as causes of prescribing errors in hospital inpatients, that some of the reasons for serious prescribing errors included overworked doctors, improper communication, lack of adequate supervision and even low morale (Coombes *et al.,* 2008; Dornan *et al.,* 2009; Dearden *et al.,* 2015; Tully *et al.,* 2009; Dean *et al.,* 2002a) . The improper communication was noted in both written and verbal communications between doctors themselves and between doctors and nurses (Ross et al., 2013; Keers et al., 2015). Younger and newer doctors also feel uncomfortable to question the decisions of older staff members which they feel is incorrect and since younger doctors are the ones who do the most prescribing (Ross et al., 2008; Dornan et al., 2009; Coombes et al., 2008; Ross et al., 2013; Duncan et al., 2012), this can again result in a prescribing error (Dornan *et al.,* 2009; Lewis *et al.,* 2009). Furthermore younger doctors sometimes choose not to ask questions in

an effort to try and fit into the culture within the ward and as a result of this often commit prescribing errors (Lewis *et al.,* 2014). Often these younger doctors are too scared to ask questions because their perception is that they are now doctors and are meant to know what is going on (Lewis *et al.,* 2014; Kennedy *et al.,* 2009). Furthermore the older doctors that they are meant to consult are often the same doctors who are required to assess their progress as a result of this they fear looking incompetent in front of these doctors (Lewis *et al.,* 2014; Kennedy *et al.,* 2009). With regards to written communications often younger doctors did not understand the handwriting of their older colleagues or they could not understand abbreviations or prescriptions instructions that were provided (Dornan *et al.,* 2009; Ross *et al.,* 2013; Dean *et al.,* 2002a). Furthermore, there was also reports of written communications being incomplete and this leading to a prescribing errors (Ross *et al.,* 2013; Franklin *et al.,* 2011; Dearden *et al.,* 2015).

Additionally Coombes *et al.,* (2008); Dean and her colleagues (2002a), Dornan *et al.,* (2009), Lewis *et al.,* (2014) and Duncan *et al.,* (2012) found that interviewed participants complained about a lack of knowledge especially regarding the dosing of medicines. Lack of knowledge seems to be a causative factor as well as gaps in prescribing training (Dornan *et al.,* 2008; Lewis *et al.,* 2014). Some felt that they had inadequate knowledge or skill or even inadequate experience and training, however very few made calculation errors (Coombes et al., 2008). Most of these doctors then depended on the pharmacist or nurses to tell them whether a dosing error had occurred (Ajemigbetse *et al.,* 2013; Ross *et al.,* 2013; Lewis *et al,* 2014; Dornan *et al.,* 2009; Franklin *et al.,* 2011). Situations have been noted by Keers *et al.,* (2015) in which nurses have not picked up on prescribing errors and have thus committed administration errors, thus showing the problems with junior doctors relying on a nurse to

spot a prescribing error. The reliance on nurses to help them to prescribe the medicine has also been a causative factor in prescribing errors as often junior doctors simply do what they are told to do (Ross *et al.,* 2013; Dornan *et al.,* 2008).

Another cause of prescribing errors on the part of younger doctors was their lack of familiarity with the tools required for prescribing as well as how to fill in prescribing charts correctly (Dearden *et al.,* 2015; Dornan *et al.,* 2009; Duncan *et al.,* 2012). The doctors interviewed in these studies expressed not being taught how to fill in these charts when they were at university and as a result of that they did not know how to fill them in. When looking specifically at charting, Coombes *et al.,* (2008) also noted that the charting systems in hospitals could sometimes lead to prescribing errors due to their poor design and conception. Often not enough space was left for important information to be filled in (Coombes *et al.,* 2008).

2.10 Consequences of Prescribing Errors

Prescriptions are written at the beginning of the therapeutic process. Thus, it is important to note that once a mistake is made at the beginning of the process i.e. at prescribing, unless it is picked up, this mistake will be perpetuated throughout the process all the way through to the patient who may ultimately be harmed by it (Barber et al., 2003; Dean *et al.,* 2002).The potential harm of these errors, however, is much lower than the actual number of errors. Studies put the rate at roughly 25% of all erroneous prescriptions which have potential serious or harm causing consequences (Franklin *et al.,* 2007). Bertels *et al.,* (2013) noted that while not every prescribing error will cause harm to patients, the reality of the situation is that even relatively minor errors can affect patients in a negative manner and increase the length of the treatment process. In addition to simply causing harm to some patients, Khalili

and his colleagues (2011) also assert that these errors are responsible for considerable costs and may even account for roughly 6.5% of morbidity and mortality of all hospital admissions, of which at least two thirds may be preventable. Thus, it is in the interest of the healthcare professionals, hospital administrators and governments to ensure that systems are put in place to ensure safe and rational prescribing practices as this will ultimately reduce harm and healthcare associated costs (Khalili *et al.,* 2011).

2.11 Methods to Ensure Safer Prescribing to Reduce Errors

Some of the solutions suggested for this problem include the setting up of a core-drug list (Baker *et al.,* 2011). This will help to improve the education among the prescribers and help them to make much better and sound prescribing decisions. Some of the measures suggested by Coombes *et al.,* (2008) include changing the workload of the staff and increasing staffing levels. Splitting of shifts should also be considered, but there must be clinical handover between doctors. When interns prescribe medicine the environment must not be distracting, and the location of the medicine chart must be placed by the bedside at all times. In addition since pharmacists detect errors and improve the safety of prescribing, Coombes *et al.,* (2008) suggests that their role should be developed further. It has been suggested that doctors should be competent before ever prescribing a drug to a patient and should be able to demonstrate their competence in prescribing medicine before they even reach their pre-registration years (Barber et al, 2003; Maxwell, 2010). Maxwell (2010) also suggests that all doctors need to start their careers with a firm understanding of clinical pharmacology, as this is imperative for the rational use of medicine. Understanding clinical pharmacology will also enable doctors to critically evaluate the many sources of information that they could be presented with and respond to change. De Vries *et al.,* (1994) in the

guide to good prescribing points to the beneficial effect of a therapeutics course in the training of doctors, citing a study conducted on 219 undergraduate medical students from various countries around the world. An experiment group was given lectures in therapeutics using the guide to good prescribing and the control group was not give these lectures. The study showed that students who were given the lectures on therapeutics faired significantly better in all patient problems that were presented to them. This study clearly affirms the importance of not simply teaching pharmacology to medical students, but also adding in a component of therapeutics. Doctors should be tested by being given the drug charts and medical records of a series of patients and they should be assessed on the appropriateness of the prescribing. Ross and Loke (2009) in their review of whether educational interventions improve prescribing by medical students and junior doctors clearly noted the need for further teaching and assessment of prescribing. Barber also notes the lack of standardization of training during the pre-registration years with regards to prescribing by doctors and suggests that a newer, more standardized programme, be introduced.

The use of automated prescribing systems has been mooted as an effective tool in reducing medication related errors (Velo *et al.,* 2009). It has been suggested that these systems could reduce the risk of harm that arises from prescribing errors and improve the quality of healthcare available for the patient. The automated systems would be computerized systems that would help significantly in guiding optimal dosing. In turn this could result in a decrease in the time required for a patient to achieve stabilization and also reduce the number of adverse effects a patient could potentially experience. It could also result in decreased duration of hospital stays (Velo *et al.,* 2009).

It is also suggested that pharmacy departments need to be better resourced so they have sufficient skilled staff with adequate time to spend on clinical monitoring. Barber and his colleagues (2003) also suggest improving the way feedback is given regarding detected errors. The present system of detecting an error and indicating this error verbally to the prescriber often results in the clinical team remaining unaware of its performance as a unit. The suggestion is made that in future the information regarding prescribing errors should be fed to the team in a structured manner and discussed openly. Furthermore the culture of just verbally informing the prescriber should be changed in favour of one where the advice is documented. Pharmacists should therefore record their interventions in the patients' notes. It is also suggested that supplying a copy of the discharge prescription to the patients for their community pharmacy can significantly reduce the serious errors in medicine taking following discharge of a patient.

It is important to note that none of the literature suggests that blaming the prescriber for the error is the solution to the problem (Dean *et al.,* 2002a; Nutturno *et al.,* 2009; Reason, 2000). It is rather the suggestion of these authors to look for system errors, but it is equally important that these prescribers take responsibility for their actions at it is the only way for them to learn and grow from this experience. Furthermore, more statistical data regarding prescribing error all over the world is required, as this is an extremely important contemporary medical issue.

Avery *et al.,* (2014) points out that drug-related problems account for approximately 6.5% of all admissions to hospital of which two-thirds of these problems are actually preventable. The authors of this paper point to many interventions that can be used to reduce prescribing errors in general practice in the United Kingdom. Besides the obvious one of

making use of electronic prescribing systems with computerized clinical decision making support systems, the authors suggest that better training of GP's in the areas of therapeutics and aspects of safer prescribing. Some of these recommendations have been taken on by the royal college of general practitioners, who have in 2013 approved revisions to their curriculum in which they added five new learning objectives and revised two existing ones regarding the topics of therapeutics and safe prescribing. The authors have also piloted a study where pharmacists would provide feedback to GP's in training using a sample of 100 prescriptions written. In addition to all of this, the Avery and his colleagues (2014) developed e-learning material on the topic of prescribing in general practice which was hosted at the time of publishing on the e-learning site of the royal college of general practitioners. This allowed the authors to fill the void of lack of education that was identified as one of the reasons for the errors in general practice (Avery, 2014).

The redesigning of prescription charts has been described as a methodology to help reduce prescribing errors by Coombes *et al.,* (2009). Coombes and colleagues in 2009 built on their previous work of causes of prescribing errors from 2008 and decided to embark on a redesign of the prescription charts for patients at the hospital they investigated. The objective of their study involved the redesign of the prescription chart such that they could standardize its use through their state in Australia. Before implementing their intervention however, Coombes and colleagues (2009) observed 2300 prescribing errors in 9772 prescriptions. The redesign of the prescribing charts, were based on incident analysis of previous prescribing errors as well as work practice MDT meetings to collaborate on the design for the new charts. Importantly this was one intervention targeted at reducing prescribing errors in a paper based prescribing system as opposed to simply introducing

electronic prescribing as the so called “saving grace”. Whilst Coombes *et al.,* (2009) did acknowledge the value of having an electronic prescribing system, the true value of this study was that it used the people actually involved in the writing of prescriptions who had a problem with the current prescription charts to help come up with a solution to the problem that they could be happy with. Ultimately, the improved charts resulted in a statistically significant reduction in the number of prescribing errors which reduced from 2300 errors in 9772 prescription to 1935 errors in 10532 prescriptions after the introduction of the new prescribing charts. The number of patients with one or more errors on their prescriptions, however, did not change significantly. The percentage error reduced from 20% to 15.8% and $p < 0.05$ using a Mann Whitney u-test. Coombes *et al.,* (2009) noted, however, that electronic prescribing produced a harder barrier in the prevention of errors and was more likely to prevent the prescription of scenarios like clinically contraindicated drugs when compared to their newer modified charting system. The study was limited by the fact that it had no effect on prescriber education and lacked a control arm. There was also the possibility of bias on the part of nurses and pharmacists who collected the prescribing errors data. Ultimately, however, the chart was eventually rolled out nationwide with a few modifications after the success of this study.

Another potential method to reduce the number of prescribing errors and increase patient safety was piloted by Segal *et al.,* (2015). This innovation involved the use of a cellular phone application to help reduce prescribing errors. The study was piloted on six younger clinicians to see if it would reduce the number of dosing errors that they committed. This particular pilot study was located a hospital in Guatemala that where the population was primarily paediatric, hence dosing errors were of vital importance. The apps were loaded

onto android based smart phones that the clinicians had access to 24 hours, both at work and at home. The dosing accuracy of the prescribers involved in this study improved from 64.7% to an almost perfect score of 92.4% with the use of the application. Additionally, when compared to dosages of medicines that were previously prescribing, doses of medicines were 40% more likely to be correct after the introduction of the application. Thus, relative to the pre-app phase, the relative risk ratio of having a prescription without a dosing errors was 1.39 (95% CI 1.16 to 1.68) with $p < 0.01$. Thus, the relative were positive in favour of the application and were statistically significant. The application also reduced the length of under pressure prescribing by 1.5 minutes which was also statistically significant. The majority of doctors who used the application did, however, complain that the application did not have enough drug information in it. One of the limitations of such a study was that it did not asses other types of prescribing errors and whether or not these could be reduced with the help of an application. For example, the study did not investigate whether or not an application could reduce the number of prescriptions where a contraindicated drug for a patient was prescribed. Additionally while the clinicians in the study improved their prescribing with regards to dosing errors they still made errors occasionally. This, indicates to us as the reader, that even with a system designed to reduce errors, some errors will occasionally take place.

To reduce the number of medication errors in paediatrics, the following recommendations were made by Sandlin (2008): the establishment of a paediatric formulary, ensuring that every child is weighed and the time of admission and regularly during their stay in hospital thereafter and a paediatric pharmacist or a pharmacist with expertise in paediatrics should be on-call at all times of the day to answer prescriber questions. Additionally, all

prescriptions both from inpatients and outpatients should have the dosage calculation completed by the prescriber and both the pharmacist and nurse should double check this calculation prior to dispensing or administration of medicines respectively (Sandlin, 2008). Furthermore, wherever possible, all practitioners involved in the care of paediatric patients should have some of kind of specialty training in this field (Sandlin, 2008).

It is widely accepted that prescribing errors are a commonplace occurrence and have the potential to cause harm to patients (Franklin *et al.,* 2007). Frequently, prescribers who make these mistakes do not identify these errors by themselves and it usually somebody else who picks up these errors. Once an error is picked up, the aim of the person who finds it, is to immediately solve it and as such, there is no feedback given to the prescriber regarding the error that he/she committed. Thus, simplistically speaking the prescriber is not allowed to learn from his/her mistake (Franklin *et al.,* 2007).

Feedback is given to healthcare practitioners in other areas of their work, so the question is, can it be useful in the practice of prescribing (Franklin *et al.,* 2007). It is with this in mind that Franklin and her colleagues (2007) set out to see whether it would feasible to provide feedback to prescribers regarding the errors that they made. The study eventually concluded that it was possible to provide prescribers with feedback regarding their errors especially at the level of the team of clinicians and in a way that was acceptable to the consultants involved. The researchers do admit that they would need to put in more work if they wanted to provide feedback to specific prescribers regarding their own errors. This study, however, fails to address a key questions regarding whether providing feedback would drive down the rate of prescribing errors in hospitals.

2.12 Method of Preferred Feedback

Prior to a study by Bertels *et al.,* (2013), very little evidence existed as to whether providing feedback to prescribers in order to reduce prescribing errors actually worked. One study that did look at a combination of providing feedback and educational interventions to prescribers was an uncontrolled study. It did, however, reduce the number of errors that were committed. Bertels and colleagues (2013) remind us that the methodology through which feedback is delivered to prescribers, ultimately predicts its outcome with regards to success and acceptability. Bertels and colleagues (2013) attempted to understand the perceptions of junior doctors and ward pharmacists regarding providing individual feedback on the errors they had committed during prescribing. The study took place through three teaching hospitals and pharmacy departments. Within these hospitals prescribing for in-patients were largely paper-based and there were set drug charts used to standardize practice. The researchers developed 2 different questionnaires; one set was to be given to junior doctors and one set was to be given to ward pharmacists. The questionnaires aimed to glean the different groups perceptions regarding the usefulness of feedback, preferred methodology to give feedback and number of times feedback should be given to prescribers based on the previous literature and experts in the field's experience. The questionnaires consisted of a few open ended questions with the majority of questions asking the participants to rate a statement on a 5-point type scale which ranged from -2 to +2 (Bertel *et al.*, 2013). Ultimately the study found that junior doctors preferred to have direct and individualized feedback on the errors that they committed and that pharmacists should collaborate with doctors to agree on the best method to provide this feedback given their local circumstances.

A 2016 study by Reynolds *et al.,* looked at improving feedback to junior prescribers regarding prescribing errors. The study was a mixed-methods evaluation of the improvement that came as a result of the intervention on the part of the research team. The research team found that despite their intervention strategy they only had a small to moderate positive effect on professional practice.

CHAPTER 3: THE PRESCRIBING ERROR STUDY

3.1 Aim

To classify and determine the occurrence of medication prescribing errors in selected wards prescriptions in an academic teaching hospital in Johannesburg. In addition to determine the reasons why these errors occur.

3.2 Objectives

In order to achieve these aims, the following objectives were determined:

1. To determine the number of prescribing errors in the selected wards i.e. the medical, surgical, psychiatric and paediatrics ward.

2. To classify the errors according to the classification system of Dean *et al.,* (2000) for adult prescribing errors and Ghaleb et al., (2005) for the paediatric population.

3. To compare the number of errors from the different wards to each other.

4. Determine factors contributing to errors on the wards.

5. To make recommendations with regards to reducing the number of errors found in prescribing.

3.3 Methodology

3.3.1 Ethics

Permission to perform this study was obtained from the Human Research Ethics Committee (HREC) of the University of the Witwatersrand (Certificate number M110603). Whilst the original intention of the project was to do a prospective analysis of patient records from real-time prescribing, the ethics committee suggested a retrospective analysis of patient's records as being more suitable to the scope of the project and less likely to target individual

prescribers' errors and entrench the idea that the project would be looking at systems errors. Particular ethical issues associated with this project included:

1. For the records review – hospital permission to change patients identifiers.

2. For focus groups – informed consent and audio recordings storage as well as the handling of recordings according to the HPCSA.

3. No anonymity but plea for confidentiality in focus groups.

4. No names on transcripts of focus groups.

5. No focus on individuals regarding the prescribing errors that was committed. An undertaken was given to follow a 'systems' approach and exclude identification of prescribers.

It would have been useful to have attributed the errors to particular groups of prescribers e.g. interns, medical officers, registrars or consultants, however the ethics committee made it clear that no doctors names or signatures or any identifiable markers of the doctor who wrote the prescription could be recorded. A copy of the ethics clearance certificate can be found in appendix A.

3.3.2 Design

The study was a mixed methods study conducted in two parts. Part one, which was quantitative, was a retrospective analysis of patient records to examine the occurrence of prescribing errors in the selected teaching hospital. Ferner (2009) also noted that a retrospective review of patient records was consistent with a study conducted by pharmacist and gives a more complete understanding of medication errors. Data collection

took place between June 2012 and November 2012. Data was collected for the months of April and May 2012. Part two, which was a qualitative study, involved investigating the potential causes of prescribing errors in the hospital. Data collection took place between June 2015 and October 2015.

3.3.3 Setting

The hospital was purposively selected because of its close proximity to the University's medical school and because of the diversity of patient populations and cases presenting, owing to its status as a tertiary academic teaching hospital. All prescribing that was done in the hospital under study was on handwritten prescription charts. During the quantitative phase of the study, four wards were selected from a group of similar wards in the hospital on the basis of the consultant's willingness to have the ward included in the study. The four wards were: a general medical ward, a psychiatric ward, a general surgical ward and a paediatric ward. These specialties were chosen as they represented an array of different types of medicines that would be prescribed. The rationale for picking a medical ward was that it is a high turnover ward, with unplanned admissions and generally the patients admitted have multiple morbidities that required a number of complex medicine regimens to manage (Franklin *et al*., 2011). The surgical ward was chosen as patients generally have longer lengths of stay with a mix of emergency and elective surgery and there is a greater focus on antibiotic as well as analgesic use (Franklin *et al*., 2011).The psychiatric ward was chosen because the length of stay of patients tends to vary depending on their condition and there is greater focus on prescribing psychiatric and neuropsychiatric medications. Literature suggested that paediatric prescribing error was higher than adult patient prescribing error (Ghaleb *et al.,* 2010) and thus a paediatric ward was chosen to examine whether this would be similar, in a large teaching hospital in Johannesburg. Permissions

were obtained in writing from the head of the hospital as well as from the heads of the different wards that were investigated in this study.

3.3.4 Definitions and Error Checklist

The definition chosen for adult prescribing error and the scenarios that constituted prescribing errors were modelled on the study by Dean *et al.,* (2000) which has been extensively used by other authors in similar studies of this nature (Franklin *et al.,* 2011; Lewis *et al.,* 2009). The checklist as part of the Case Report Form (CRF) can be found as part of Appendix B. Whilst effort was made to use the same list of scenarios as defined by Dean *et al.*, (2000), one scenario was changed to reflect the context of South Africa. The scenario of "prescribing a dose of a drug above the recommended dose defined in the British National Formulary (BNF)" was changed to read "prescribing a dose of a drug above the maximum recommended dose defined in the South Africa Medicines Formulary (SAMF)". The checklist that was used to determine the scenarios that constituted paediatric prescribing error is included in Appendix B. The scenarios for paediatric prescribing errors were referenced from Ghaleb *et al.,* (2005) and Ghaleb *et al.,* (2010).

3.3.5 Part 1: Prescription Review Data Collection

The sample size was calculated as 1067 (95%CI, 3%CL). Due to slow patient turnover, it was decided that two months would be used to undertake this study instead of one month in order to obtain the sample size that was required. The months that fell within the included study period were April and May 2012 in all the above mentioned wards. Data were collected between the months of June 2012 and November 2012 for each of the wards included in the study. The slow rate of data collection was due to all patient records being stored on microfilm. Data and could only be view on microfilm viewers of which only two

were functional within the records room at the teaching hospital. There were also periods of time when both microfilm viewers were in use by the hospital staff and thus data collection could not take place. In addition to this, patients files were missing and required multiple search attempts before some of them could be located while others were not located and thus considered lost. The admissions for April and May 2012 for each of the wards along with patient's particulars were obtained from the ward register.

3.3.5.1 Prescription Review Data Extraction

The patient numbers were then used to obtain the patient's records from the hospital's record room facilities. Each patient from each ward included in the study was given a non-identifiable patient code, and a record of the patient's information along with their corresponding codes were kept on a password protected excel spreadsheet with accessibility to the researcher and supervisor only. Ward prescriptions from the determined dates were transcribed by the researcher onto a specially designed case report form (CRF). All records were only available for viewing on microfilm and there were instances where a patient's records had gone missing or were not in the records room at the time of the data capture process. To ensure that the maximum number of records could be found, the researcher searched for the records again on a monthly basis, however in some of these cases the records were still not located. After multiple search attempts if the records could not be found they were excluded from the relevant analysis. The case report form contained demographic information (age, sex, patient code), a place to transcribe the medicines and the prescription as well as a checklist of the scenarios defined as errors by Dean *et al.,* (2000) for adults. The CRF for paediatric patients had similar information regarding demographics (age, sex, patient code, weight), and a place to transcribe the prescription

and medicines but it also contained a space for dose calculations as well as a checklist of scenarios defined as errors by Ghaleb *et al.,* (2005). All prescriptions written for each patient were transcribed including admission prescriptions and discharge prescriptions. Both once off and continuous IV prescriptions were transcribed.

3.3.6 Part 1: Prescription Review Data Analysis

The primary aim of this part of the study was to quantify and to determine the types of prescribing errors that took place in the hospital during this time period.

3.3.6.1 Prescription Error Determination and confirmation of errors

All the transcribed prescriptions were audited using a range of reference materials including current therapeutic guidelines, the South African Medicines Formulary (SAMF), the South African Department of Health (DOH) hospital guidelines as well as textbooks of therapeutics and current textbooks of clinical pharmacology and medicine as well as the online reference "UpToDate". Each individual prescribing error that was identified was then assigned to one of the scenarios considered an error by Dean *et al.,* (2000) for the adult population and Ghaleb *et al.,* (2005) for the paediatric population. The transcribed and interpreted data sheets were then reviewed by a consensus committee of professionals comprising a nurse, a doctor, a pharmacist and an academic pharmacologist. Each professional reviewed the data separately and then differences in interpretation were discussed at a joint meeting, in order to obtain a consensus. The committee considered all the transcribed data which the researcher had deemed to contain an error and also reviewed one in twenty prescriptions containing non-error data to ensure the integrity of the data analysis process. To avoid the possibility of bias, all suspected cases of illegibility were photographed during the data

extraction process and shown to the consensus committee and the prescriptions were only judged to be illegible if the committee agreed that it was illegible.

3.3.6.2 Prescription Review Data Analysis

The verified data was then captured on specially designed excel spreadsheets and simple descriptive statistics were generated using Microsoft Excel 2010. Ferner (2009) and Franklin *et al.,* (2010) noted the importance of stating what the numerator and denominator are in a study investigating medication errors. The numerator and denominator as chosen in this study are consistent with the methodology chosen i.e. a retrospective review of patients records. Ferner (2009) also notes that this methodology gives a more complete view of patients' records.

The percentage error for a month period was calculated using the following formula:

$$\%\ error\ per\ ward\ = \frac{number\ of\ errors\ for\ the\ ward}{total\ number\ of\ precriptions\ written\ in\ that\ ward} \times 100$$

This formula is a modified version of the formula used by Dean *et al.,* (2002) and Franklin *et al.,* (2011). The formula was modified by making the denominator the total number of prescriptions as opposed to the total number of medication orders. The percentage error for each month was calculated as well as the average percentage error for the two month period.

The verified data was then numerically coded for each category of errors and then analyzed using Stata (version 13.1). Inferential statistics were determined using the value of $p \leq 0.05$ taken as statistically significant. Fisher's Exact tests were used to analyze the data for comparing male vs female in terms of the total number of errors as well as April vs May in in

terms of the number of the total number of errors. A Fisher's Exact test was also used to analyze the data comparing adult vs paediatrics in terms of the total number of errors. This test was used because the number of prescriptions with errors in each category did not exceed 5 in every group. Multinomial Logistic Regression was used to compare all four wards to each other to note whether or not there was a statistically significant difference between the wards in terms of the total number of errors as well as to determine 95% Confidence Intervals (CI) for each of these categories. Logistic regression analysis was chosen because of its utility in comparing error occurrence in the wards (Franklin *et al.,* 2011; Condren *et al.,* 2014). Relative Risk Ratios were chosen to compare the risk of having a prescription with an error on it when admitted to any one of the four wards.

3.3.7 Part 2: Qualitative Data Collection – Further Investigation of Prescribing Error

The researcher kept a field journal during all the time spent on the wards to ascertain information regarding the process of prescribing and dispensing medications that took place on the wards as well as the roles of each of the members in the healthcare team in relation to medicines management on the ward. Comments in the field journal were integrated into the thematic analysis of the focus groups where clarity was required.

The researchers also conducted three occupation-specific focus groups with doctors and nurses in the wards to determine the causes of prescribing error related to systems. Prompting questions for the focus groups were formulated using the causes of prescribing error demonstrated by Dean *et al.,* (2002a) and Coombes *et al.,* (2008). The researchers used these as guiding questions to initiate the discussion. A copy of the focus group questions can be found in Appendix D. Two nurses' focus groups were held and one focus group with the doctors was held. It was originally intended to hold focus groups until data

saturation occurred. For the nurses, the first focus group had a small number of participants, however many of the same themes identified were common to the larger subsequent discussion. For the doctors it was logistically difficult to arrange a suitable time for focus group participation and thus only one group was conducted.

Participants were invited to join each of the different profession-specific focus groups which were held on separate days. The groups of participants came from all the wards under study as well as from other wards throughout the hospital. Written consent was given by all those who participated in the focus groups and written consent was also given by the participants to be audio recorded. A copy of the informed consent forms and the consent form to have the focus groups audio recorded can be found in Appendix C. Although anonymity in a focus group is not possible, all participants were reminded of the need to keep the information heard or contributed to the focus group, as well as the identity of the participants, confidential and not to repeat what they heard in the focus group to any other individual. The two nursing focus groups consisted of professional nurses, while the doctor's focus group consisted of consultants, registrars, medical officers and interns. The doctor's focus group was so diverse because it was the only time that all of these four different groups could meet to take part in the focus group. All the focus groups were audio recorded so that they could later be transcribed for data analysis purposes. The participants of all three sets of focus groups were offered a chance to read the transcript of the focus groups they had participated in to ensure the accuracy of the transcription process.

3.3.8 Part 2: Qualitative Data Analysis– Further Investigation of Prescribing Error

Each focus group was individually transcribed from the audio recording. The transcription of each focus group was then analysed using thematic content analysis according to the method of Hsieh and Shannon (2005). Thematic content analysis has been described as a method for identifying, analyzing and reporting themes within specific data (Braun and Clarke, 2006). Thematic content analysis was chosen because it described patterns across the data. The six phases described by Braun and Clarke (2006) were followed in order to analyse the data. This framework for analysis added to the trustworthiness of the findings generated from this study. All similar codes were grouped together to make up specific categories. Similar categories were then grouped together to produce themes. Consensus on the codes, categories and themes were obtained through a process of peer debriefing between the researcher and the supervisor. This reduced bias in the analysis and improved the confirmability of the results (Long and Johnson, 2000). It also improved objectivity and ensured this study's trustworthiness (Long and Johnson, 2000). Outliers which were relevant and found to be of value were also described. McPherson and Thorne (2006) noted the value of outliers and exceptions which do not correlate with most of the data. Outliers as the authors noted added richness to the data that would not be possible from quantitative analysis (McPherson and Thorne, 2006).

CHAPTER 4: RESULTS FROM PRESCRIPTION DATA REVIEW

4.1 Introduction

During the two month review period for prescriptions, a total of 1843 prescriptions were collected across the four wards under study in the hospital. Data were collected using the patient codes obtained from the ward admission register and then locating the patient's files on microfilm within the records room of the hospital. Relevant data were then extracted from the files and recorded on the case report forms. Analysis took place as a separate phase after all the data had been collated to ensure all the data was analysed in the same way. Table 5 summarizes the demographic data obtained from the wards.

Table 5: Summary of demographic and records obtained from all four wards

Ward	Month	Number of approved beds	Number of patients admitted	Average number of items on the prescriptions	Percentage of records that were found	Median age of patients	Number of males vs females	Number of prescriptions written
Medical Ward	April	24	92	2.47	70.65%	49 years (23-80)	38 M &27 F	269
	May		102	2.35	68.63%	42 years (18-88)	47 M&45 F	432
Surgical Ward	April	28	46	2.10	89.13%	45 years (14-89)	25 M& 21F	106
	May		70	1.80	90%	46 years (14-88)	40 M&30 F	165
Psychiatric Ward	April	20	28	3.00	85.72%	32 years (21-89)	15 M&9 F	148
	May		44	1.76	81.81%	33 years (18-89)	19 M&25 F	264
Paediatric Ward	April	31	105	1.87	93.33%	2 years (birth-13)	36 M&30 F	218
	May		151	2.14	90.06	2 years (birth-14 years)	61 M& 34 F	241

4.2 Medical Ward

The general medical ward in the academic hospital at the time of the data collection process consisted of 24 approved beds. The ward had 7 professional nurses, 1 intern, and 4 registrars. During this period the ward in question had 11 consultants. A total of 701 prescriptions were collected for the period of April and May 2012.

During the month of April 2012, there were 92 admissions to the ward. Of the 92 admissions, a total of 27 patient records were deemed to be lost and could not be found after multiple search attempts. Thus the percentage of records that could be found was 70.65%. Of the patients' records that could be found, there were 38 male patients admitted to the ward and 27 female patients a ratio of 1.4:1. During this period the median age of the admitted patients was 49 years (range 23-80). A total of 269 prescriptions were written from the records that were found. There were 128 prescriptions written for the male patients in comparison to the 141 prescriptions written for the female patients a ratio of 1:1.1. There was an average of 2.47 items written on each patient prescription i.e. an overall of 655 items prescribed.

During the month of May 2012, there were 102 new admissions to the ward. Carry over patients did not contribute to the numbers of new patients in the second month. Of these admissions, a total of 32 patient records could not be found after multiple search attempts and were thus considered to be lost. Thus the percentage of records that could be found was 68.63%. There was patient cross over, as some patients who were admitted in April who continued to be patients in the ward during May 2012. There were 47 male patients on the ward from the records that could be found and 45 female patients at the time of the data collection process i.e. a ratio of 1.04:1. During this period, the median age of the

admitted patients was 42 years (range 18-88). A total of 432 prescriptions were written during this period from the records that could be found. Of these, 223 prescriptions were written for male patients in comparison to 209 prescriptions for the female patients i.e. a ratio of 1:1.1. There was an average of 2.35 items written on each patient prescription i.e. a total of 1026 prescribed items.

4.3 Surgical Ward

The general surgical ward in the academic hospital at the time of the data collection process had a total of 28 approved beds. The ward had 8 professional nurses, no interns and 2 registrars. The ward also had 3 consultants. A total of 271 prescriptions were collected for the period of April and May 2012.

During April 2012, 46 patients were admitted to the ward. Of these patients, a total of 5 patient's records were considered to be lost after multiple search attempts. Thus the percentage of records that could be found was 89.13%. Of the patients' records that could be found, there were 25 male patients admitted to the ward and 21 female patients i.e. a ratio of 1.2:1. During this period the median age of the admitted patients was 45 years (range 14-89). A total of 106 prescriptions were written from the records that were found. There were 63 prescriptions written for the male patients in comparison to the 43 prescriptions written for the female patients i.e. a ratio of 1.5:1. There was an average of 2.10 items written on each patient prescription i.e. a total of 223 items.

During the month of May 2012, there were 70 new admissions to the ward. Of these admissions, a total of 7 patient records could not be found after multiple search attempts and were thus considered to be lost. Thus the percentage of records that could be found

was 90%. There was patient cross over as some patients who were admitted in April who continued to be patients in the ward during May 2012. There were 40 newly admitted male patients and 30 newly female patients at the time of the data collection process i.e. a ratio of 1.3:1. During this period, the median age of the admitted patients was 46 years (range 14-88). A total of 165 prescriptions were written during this period from the records that could be found. Of these, 104 prescriptions were written for male patients in comparison to 61 prescriptions for the female patients i.e. a ratio of 1.7:1. There was an average of 1.80 items written on each patient prescription i.e. a total of 297 items.

4.3 Psychiatric Ward

The psychiatric ward at the academic hospital had a total of 20 approved beds. The psychiatric ward was only intended for patients with acute illnesses and was not a long term facility. The ward had 10 professional nurses, 4 interns and 4 registrars. The ward also had 1 consultant. A total of 432 prescriptions were collected for the period of April and May 2012.

During April 2012, 28 patients were admitted to the ward. Of these patients, a total of 4 patient's records were considered lost after multiple search attempts. Thus the percentage of records that could be found was 85.72%. Of the patients' records that could be found, there were 15 new male patients admitted to the ward and 9 female patients i.e. a ratio of 1.7:1. During this period the median age of the admitted patients was 32 years (range 21-89). A total of 148 prescriptions were written from the records that were found. There were 98 prescriptions written for the male patients in comparison to the 50 prescriptions written for the female patients a ratio of 1.9:1. There was an average of 3 items written on each patient prescription i.e. a total of 444 items were prescribed.

During the month of May 2012, there were 44 newly admissions to the ward. Of these admissions, a total of 8 patient records could not be found after multiple search attempts and were thus lost. Thus the percentage of records that could be found was 81.81%. There was, however, patient cross over, some patients who were admitted in April who continued to be patients in the ward during May 2012. There were 19 newly admitted male patients and 25 newly female patients at the time of the data collection process i.e. a ratio of 1:1.3. During this period, the median age of the admitted patients was 33 years (18-89). A total of 264 prescriptions were written during this period from the records that could be found. Of these, 91 prescriptions were written for male patients in comparison to 173 prescriptions for the female patients i.e. a ratio of 1:1.9. There was an average of 1.76 items written on each patient prescription meaning that a total of 465 items were prescribed.

4.4 Paediatric Ward

The paediatric ward at the academic hospital had a total of 31 approved beds. The ward had 10 professional nurses, 4 interns and 2 registrars. The ward also had 2 consultants during the period of study. A total of 459 prescriptions were collected for the period of April and May 2012.

During April 2012, 105 patients were admitted to the ward. Of these patients, a total of 7 patient's records were considered lost after multiple search attempts. Thus the percentage of records that could be found was 93.33%. Of the patients' records that could be found, there were 36 male patients admitted and 30 female patients to the ward that is a ratio of 1.2:1. During this period the median age of the admitted patients was 2 years (ranging from birth-13). A total of 218 prescriptions were written from the records that were found. There were 134 prescriptions written for the male patients in comparison to the 84 prescriptions

written for the female patients i.e. a ratio of 1.6:1. There was an average of 1.87 items written on each patient prescription meaning that a total of 407 items were prescribed.

During the month of May 2012, there were 151 new admissions to the ward. Of these admissions, a total of 15 patient records could not be found after multiple search attempts and were thus lost. Thus the percentage of records that could be found was 90.06%. There were 61 newly admitted male patients and 37 newly female patients at the time of the data collection process that is a ratio of 1.6:1. During this period, the median age of the admitted patients was 2 years (ranging from birth-14 years). A total of 241 prescriptions were written during this period from the records that could be found. Of these, 150 prescriptions were written for male patients in comparison to 91 prescriptions for the female patients that is a ratio of 1.6:1. There was an average of 2.14 items written on each patient prescription meaning that a total of 517 items were prescribed.

4.5 Number of Errors and Percentage Error Calculation

4.5.1 Medical Ward

For the month of April, there were 52 prescriptions with errors out of a total of 269 prescriptions that were collected. Of these 52 prescriptions with errors, there were 47 prescriptions with one error on them, and 5 prescriptions with two errors on them. Thus a total of 57 prescribing errors took place on 269 written prescriptions. Therefore, the percentage prescription error for the month of April was 21.19%. For the month of May, there were 79 prescriptions with errors out of a total of 432 prescriptions collected. Of the 79 prescriptions with errors, there were 75 prescriptions with one error only and 4 prescriptions with 2 errors. Thus a total of 83 prescribing errors took place on 432 written

prescriptions with the percentage prescription error for the month of May being 19.21%. For the two month period under investigation in this study, there were 701 prescriptions written. Of these 701 prescriptions, there were 570 prescriptions with no errors, and 122 prescriptions with one error and 9 prescriptions with two errors. The percentage error rate for the two month period of April and May was 19.97%.

4.5.2 Surgical Ward

For the month of April in the surgical ward, there were 16 prescriptions with errors on them out of a total of 106 prescriptions collected. Of these 16 prescriptions with errors, 14 prescriptions had one error on them, while 2 prescriptions had two on them. Thus a total of 18 prescribing errors took place on 106 written prescriptions that were collected over this period. Therefore, the percentage prescription error for the month of April was 16.98%. For the month of May, there 17 prescriptions with errors on them out of a total of 165 prescriptions collected. Of the 17 prescriptions with errors, 16 prescriptions had one error on them, while 1 prescription had two errors on them. Therefore, the percentage prescription error for the month of May was 10.90%. Taking into account the two month period under investigation in this study, there were 271 written prescriptions collected. Of these, 30 prescriptions had one error on them and 3 prescriptions had two errors on them with 238 prescriptions having no errors on them. Thus a total of 36 errors took place over the two month period with a corresponding error rate of 13.28%.

4.5.3 Psychiatric Ward

In the month of April, there were 18 prescriptions with errors on them out of a total of 148 prescriptions collected. Of the 18 written prescriptions with errors, there were 12 prescriptions with just one error, 5 prescriptions with two errors and 1 prescription with four errors. This was the only occasion where a prescription had four errors on it. Thus a total of 26 prescribing errors took place on 148 written prescriptions. Therefore, the percentage prescription error for the month of April was 17.57%. For the month of May, there were 33 prescriptions with errors on them out of a total of 264 prescriptions collected. Of the 33 prescriptions with errors, 22 prescriptions had one error on them, while 11 prescriptions had two errors on them and one prescription had three errors on it. Thus a total of 46 prescribing errors took place in the month of May on 264 prescriptions. Therefore, the percentage prescription error for the month of May was 17.42%. When one takes into account the two month period under investigation in this study, there were 412 handwritten prescriptions collected. Of these, 33 prescriptions had one error on them and 16 prescriptions had two errors on them, 1 prescription had three errors on it and 1 prescription had four errors with 361 prescriptions having no errors on them. Thus a total of 72 errors took place over the two month period with a corresponding error rate of 17.48%.

4.5.4 Paediatric Ward

For the month of April, there were 57 prescriptions with errors on them out of a total of 218 prescriptions collected. Of the prescriptions collected for this period 57 prescriptions with errors, 50 prescriptions had one error on them and 7 prescriptions with two errors. Thus a total of 64 prescribing errors took place on 218 written prescriptions. Therefore, the percentage prescription error for the month of April was 29.36%. For the month of May,

there were 67 prescriptions with errors on them out of a total of 241 prescriptions collected. Of the 67 prescriptions with errors, 55 prescriptions had one error on them, while 9 prescriptions had two errors on them and 3 prescriptions had three errors on it. Thus a total of 82 prescribing errors took place in the month of May on 241 prescriptions, making the percentage prescribing error for this period 34.02%. When one taking into account the two month period under investigation in this study, there were 459 handwritten prescriptions collected. Of these, 105 prescriptions had one error on them and 16 prescriptions had two errors on them, 3 prescriptions had three errors on it with 335 prescriptions having no errors on them. Thus a total of 146 errors took place over the two month period with a corresponding error rate of 31.80%.

4.6 Differences Between April and May in terms of Data Collection

There were 741 written prescriptions collected for the month of April, with 598 having no errors and 123 prescriptions having one error, 19 prescriptions having two errors, no prescriptions with three errors and one prescription with four errors. In comparison to this, for the month of May had 1102 written prescriptions, 906 of which had no errors, 167 had one error, 25 prescriptions had two errors, 4 prescriptions had three errors, and there were no prescriptions with four errors. Using the Fisher's exact test, to compare the data from April and May, it was determined that there was no statistically significant difference between the two months with $p=0.286$ indicating that was no statistically significant difference between the data collected in both months. Table 6 demonstrates the differences between April and May in terms of prescription error data collected.

Table 6: The differences between April and May data in terms of prescription errors

Month	Overall n(%)	No errors n(%)	One error n(%)	Two errors n(%)	Three errors n(%)	Four errors n(%)	P-value
April	741 (40.21%)	598 (39.76%)	123 (42.41%)	19 (43.18%)	0 (0%)	1(100%)	>0.05
May	1102 (59.79%)	906 (60.24%)	167 (57.59%)	25 (56.82%)	4 (100%)	0 (0%)	
Total	1843 (100%)	1504 (100%)	290 (100%)	44 (100%)	4 (100%)	1 (100%)	

4.7 Gender Differences in Prescribing Errors

Given that the number of prescriptions written for male patients (n=991) is larger than the number of prescriptions written for female patients (n=852), it is important to ask whether these is a statistically significant difference between the number of errors between male and female patients. Table 7 describes the differences in the data between male and female patients.

Table 7: The differences between male and female data in terms of prescriptions

Sex	Overall n(%)	No errors n(%)	One error n(%)	Two errors n(%)	Three errors n(%)	Four errors n(%)	P-value
Male	991 (53.77%)	787 (52.33%)	172 (59.31%)	29 (69.51%)	2 (50%)	1 (100%)	<0.05
Female	852 (46.23%)	717 (47.67%)	118 (40.69%)	15 (34.09%)	2 (50%)	0 (0%)	
Total	1843 (100%)	1504 (100%)	290 (100%)	44 (100%)	4 (100%)	1 (100%)	

For the male patients there were 787 prescriptions without any errors, 172 prescriptions with one error, 29 prescriptions with two errors, 2 prescriptions with 3 errors and 1 prescription with four errors. This equates to a total of 240 prescription errors for male patients. Taking into account the number of prescription written for males, the percentage error for males can be calculated using the same formula as was used to calculate the percentage error for each ward. The percentage error for the male population in this sample was 24.21%.

In comparison to this, there were 717 prescriptions without any errors for female patients, 118 prescriptions with one error, 15 prescriptions with two errors, 2 prescriptions with errors and no prescriptions with four errors. This equate to a total of 154 prescription errors for female patients within this sample. The percentage error for the female population in this sample was 18.07%.

Thus the percentage error for male patients was higher than that of female patients. In addition to this, the number of errors in the male population was higher than that of the female population in this sample. Since there is a disparity in the number of prescriptions written for males in comparison to females a Fisher's exact test was used to determine whether there was a statistically significant difference between male and female patient with regards to total errors, and was statistically significant.

4.7 Comparing the Adult to the Paediatric Population in terms of Prescribing errors

One of the objectives of this study was to see if there were any differences between prescribing errors in adults and paediatric patients. In total there were 1383 prescriptions written for adults and 460 prescriptions written for the paediatric population. Table 8 summarizes the comparison between the adult and paediatric population in terms of prescribing error. There was one paediatric patient who was not admitted to the paediatric ward but was admitted to one of adult ward for specialized care, which is why there are 460 paediatric patients in total and not 459 as noted in the data from the paediatrics ward. In terms of the adult population, there were 1168 prescriptions with no errors, 185 prescriptions had one error, 28 prescriptions had two errors, one prescription had three errors and one prescription had four errors. In total there were 248 prescriptions errors in the adult population with a percentage prescribing error of 17.93%.

For the paediatric population, 336 prescriptions had no error, 105 prescriptions had one error, 16 prescriptions had two errors, 3 prescriptions had three errors, and no prescriptions had four errors. In total there were 146 prescription errors in the paediatric population with a percentage prescribing error of 30.43%.

Table 8: Comparison of adult to paediatric prescribing error

Patient type	Overall n(%)	No error n(%)	One error n(%)	Two errors n(%)	Three errors n(%)	Four errors n(%)	P-value
Adult	1383 (75.04%)	1168 (77.66%)	185 (67.39%)	28 (63.64%)	1 (25%)	1 (100%)	<0.01
Paediatric	460 (24.96%)	336 (22.34%)	105 (36.21%)	16 (36.36%)	3 (75%)	0 (0%)	
Total	1843 (100%)	1499 (100%)	290 (100%)	44 (100%)	4 (100%)	1 (100%)	

To determine whether there was a statistically significant difference between the numbers of errors in the adult population compared to the paediatric population. The Fishers exact test was used to determine statistical significance and the p value determined was <0.01 and thus this was considered statistically significant.

4.8 Error Scenarios per Ward

All error scenarios for adults were classified according to the classification as set down by Dean *et al.,* (2000). The paediatric error scenarios were classified according to the classification of Ghaleb *et al.,* (2005).

4.8.1 Medical Ward

Table 9 outlines the scenario and the number of occurrences of each type of error depending on the month, according the classification system set down by Dean *et al.,* (2000). In the month of April, there were a total of 57 prescribing errors that took place. The most frequently occurring error scenarios were the omission of prescribers signatures

(n=18), writing of an ambiguous medication order (n=8), writing illegibly (n=8) and the prescription of a drug that comes in more than one strength as one tablet daily (n=8). Another error that was not quite as frequent but was noted in this month was the prescription of a drug in a (dose/frequency) that is not recommended for the formulation prescribed. The least frequently occurring errors included the prescription of drugs that were clinically contraindicated (n=2), the prescription of a dose or route that was not intended (n=2), prescribing too low a dose of a drug (n=2), unintentionally prescribing the wrong dose or route (n=2) and also prescribing a drug for longer than is necessary (n=1).

Table 9: The occurrence of each error scenario in the Medical Ward for the months of April and May

Error Scenario	Number of Errors in April N=57 (n)	Number of Errors in May N=83 (n)
Prescribing a drug for a patient for whom, as a result of a co-existing clinical condition, the drug is contra-indicated	2	0
Prescribing a drug in a dose that, according the South African medicines Formulary (SAMF), is inappropriate for the patients renal function	0	1
Prescription of a drug in a dose below that recommended for a patients clinical condition	2	2
Prescribing two drugs for the same indication when only one drug is necessary	0	2
Prescribing a dose or route that is not intended	2	4
Writing illegibly	8	1
Writing a drugs name using an abbreviation or other non-standard nomenclature	2	5
Writing an ambiguous medication order	8	13
Prescribing "one tablet" of a drug that is available in more than one strength of tablet	7	10
Omission of the route of administration for a drug that can be given by more than one route	2	6
Omission of the prescriber's signature	18	31
Prescribing a drug in a dose above the maximum dose recommended in the SAMF or data sheet	0	1
Misspelling a drug name	0	1
Prescribing a dose regime (dose/frequency) that is not that recommended for the formulation prescribed	5	6
Continuing a prescription for a longer duration than necessary	1	0

In the month of May, a total of 83 prescribing errors took place. The most frequently occurring of these scenarios was the omission of the prescribers signature (n=31), writing an

ambiguous medication order (n=13) and the prescription of a drug that comes in more than one strength as one tablet daily (n=10). The omission of route of administration and the prescription of the incorrect dose regimen both occurred equally in this sample (n=6). The writing of a drug name using non-standard nomenclature or using any other non-standard nomenclature occurred five times, while the prescribing or a dose or route that was not intended occurred four times.

Overall for the entire ward over the 2 month period, the largest number of errors came in the form of unsigned prescriptions which accounted for approximately 35% of all errors. This was followed by the writing of the ambiguous medication orders (15%), the prescription of a drug to take as “one tablet” when it is available in more than one strength (12%), and the prescription of a dosage regimen not for the formulation prescribed (8%). This data is represented in the pie chart shown in Figure 2. The least prevalent prescribing error scenarios included continuing a prescription for long than was necessary, the prescription of a drug that is clinically contraindicated for a patient, the prescription of a drug inappropriate for the patient's renal function according to the SAMF, the misspelling of a drug name and the prescription of a drug above the maximum dose according to the SAMF. All these account for approximately 1% of all errors in this ward during the sample period. This is followed by the prescription of a drug in a dose below that recommended for the patient's clinical condition (3%), the prescription of a dose or route that is not intended (4%) and the writing of a drug name or a drug using non-standard nomenclature (5%). The occurrence of writing an illegible prescription and the omission of the route of administration for a drug that is available in more than one route of administration both account for 6% each from the medical ward.

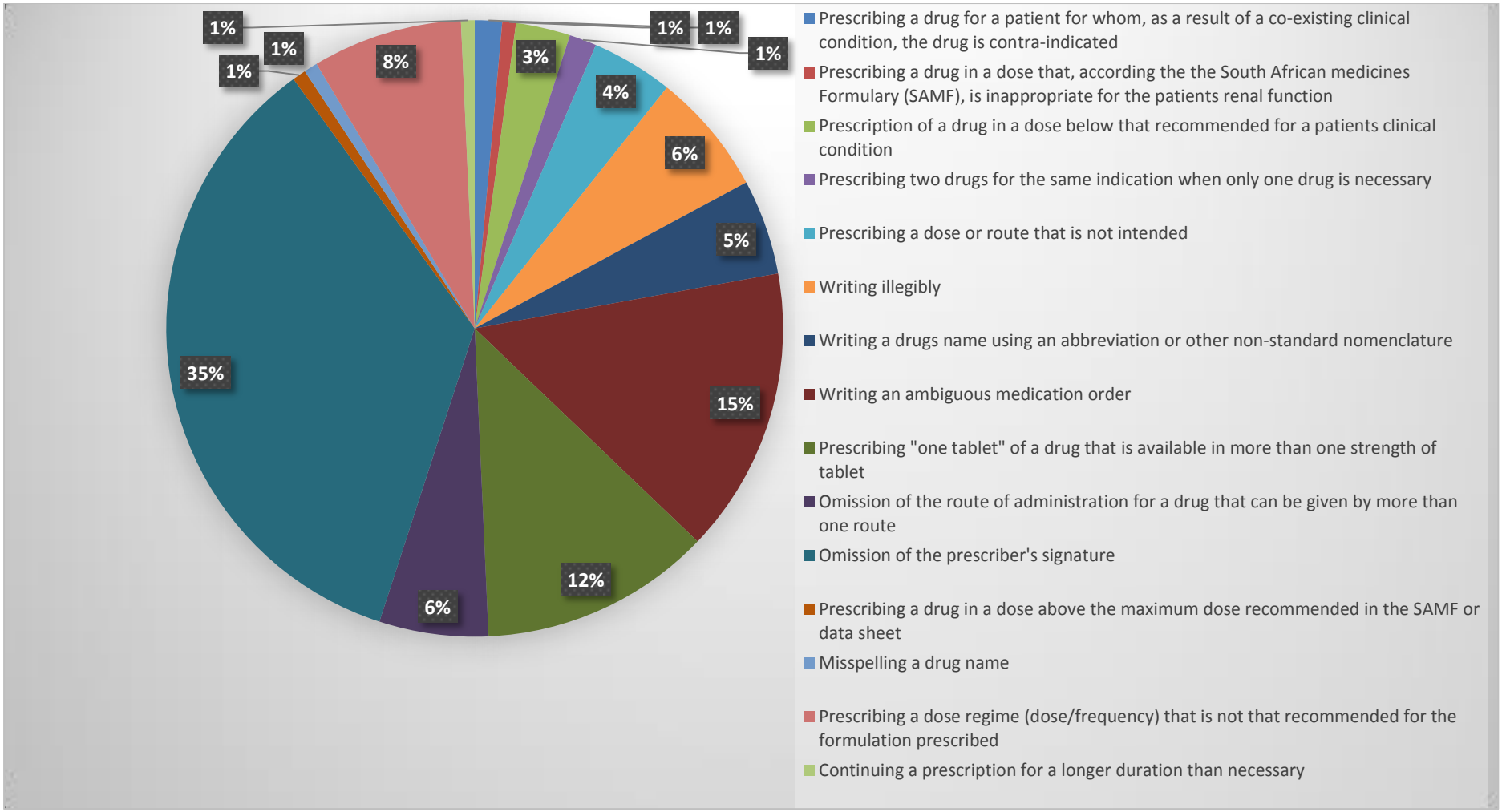

Figure 2: Percentage contribution of each error scenario in Medical Ward

4.8.2 Surgical Ward

Table 10 outlines the scenario and the number of occurrences of each type of error depending on the month in the surgical ward. In the month of April, there were a total of 18 prescribing errors that took place. The most frequently occurring error scenarios that took place in the ward included the writing of ambiguous medication orders (n=3), omission of the route of administration for drugs with multiple routes of administration (n=3), the prescription of a dosage regimen not indicated for a prescribed formulation (n=3) and the continuation of a prescription for longer than was necessary for the patient's condition (n=3). There was only 1 situation of a drug being prescription below the recommended dosage for the patient's clinical condition. The scenarios prescribing a dose or route that is not intended, the writing or a drug name using non-standard nomenclature or using other non-standard nomenclature and omission of the prescriber's signatures all occurred twice in this sample.

Table 10: The occurrence of each error scenario in the Surgical Ward for the months of April and May

Error Scenario	Number of Errors in April N=18 (n)	Number of Errors in May N=18 (n)
Prescription of a drug in a dose below that recommended for a patients clinical condition	1	0
Prescribing a dose or route that is not intended	2	1
Writing illegibly	0	2
Writing a drugs name using an abbreviation or other non-standard nomenclature	2	0
Writing an ambiguous medication order	3	5
Prescribing "one tablet" of a drug that is available in more than one strength of tablet	0	7
Omission of the route of administration for a drug that can be given by more than one route	3	0
Omission of the prescriber's signature	2	1
Prescribing a dose regime (dose/frequency) that is not that recommended for the formulation prescribed	3	2
Continuing a prescription for a longer duration than necessary	3	0

In the month of May, a total of 18 prescribing errors occurred in the sample collected for the surgical ward. The most frequently occurring scenarios were: the prescribing of “one tablet” of a drug that is available in more than one strength of tablet (n=7) and the writing of ambiguous medication orders (n=5). There were equal occurrences of the following errors: prescribing a dosage regimen not recommended for the formulation prescribed and the writing of illegible prescriptions. Both of these scenarios occurred twice in the sample

collected. The occurrence of omission of prescriber's signature and the prescription of a dose or route that was not intended occurred once in the sample collected.

Overall for the entire ward over the 2 month period, the largest number of errors came in the form of ambiguously written medication orders which accounted for 23% of all the errors in this ward. The percentage contribution of each error scenario is illustrated in Figure 3. This was followed by the prescribing of a drug to be taken as "one tablet" when it comes in more than one strength (20%), prescribing a dosage regimen that is not recommended for the formulation prescribed (14%), omission of a prescriber's signature (9%) and prescription of a dose or route that was not intended (8%). In addition to this writing illegibly and the use of non-standard nomenclature accounted for 6% of errors in this sample. Lastly, continuing a prescription for longer than is necessary and prescribing a sub-therapeutic dose for a patient's condition accounted for 3% each and were the smallest percentage error from in this sample over the two month period.

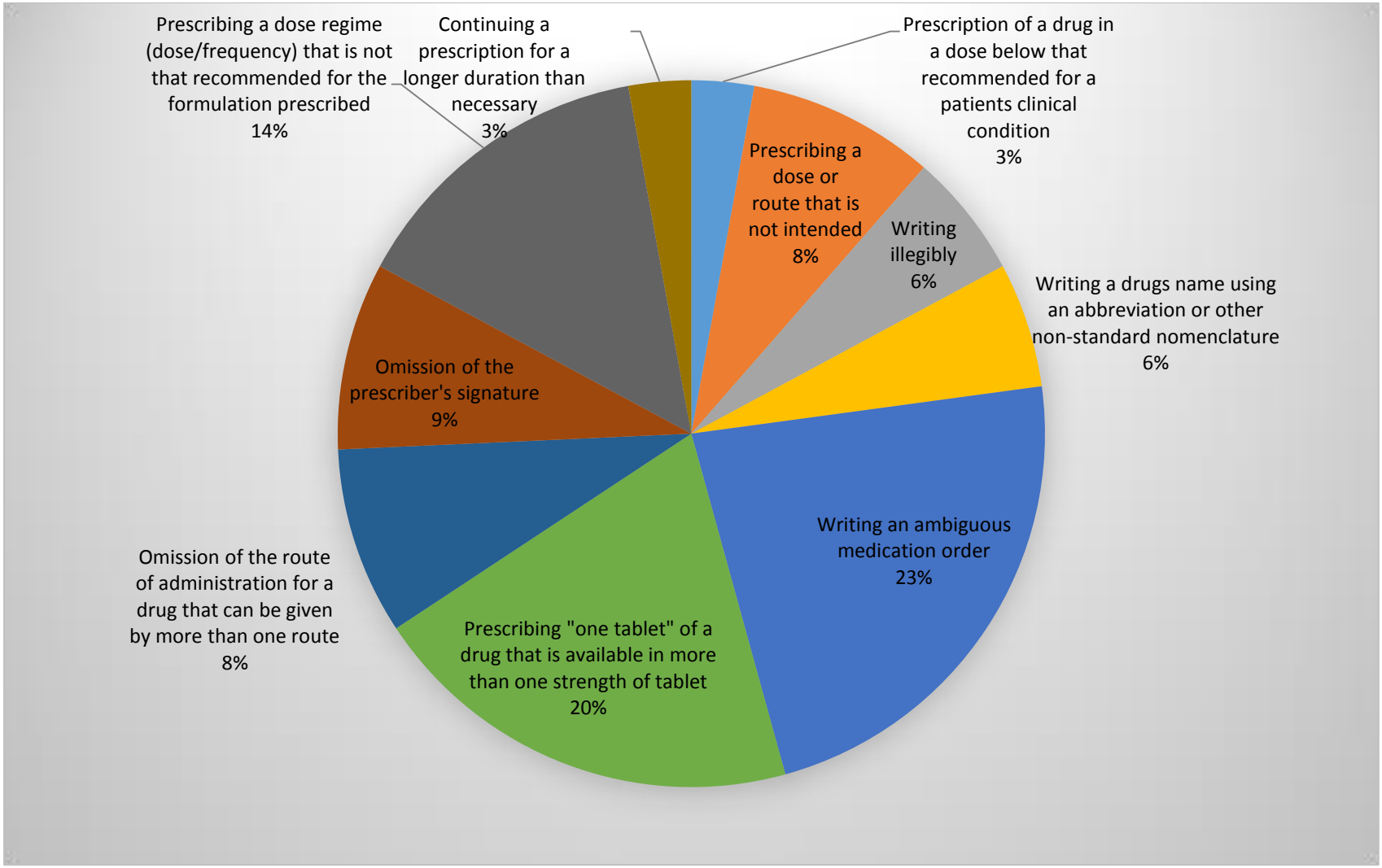

Figure 3: Percentage contribution of each error scenario in the Surgical Ward

4.8.3 Psychiatric Ward

Table 11 outlines the scenario and the number of occurrences of each type of error depending on the month in the psychiatric ward. In the month of April, there were a total of 26 prescribing errors that took place. The most frequently occurring error scenarios that took place in the ward included: the writing of ambiguous medication orders (n=7), prescribing a drug in a dose above the maximum recommended dose (n=4), omission of the route of administration for drugs with multiple routes of administration (n=3), prescribing a dose or route that was intended (n=3) and writing illegibly (n=3). This was followed by 2 instances of clinically relevant misspelling of a drug name. In both of these situations, the drug could easily be confused with another drug which had a similar spelling. There was one occurrence each of the following scenarios: not taking into accounting a potentially significant drug interaction, prescribing two drugs from the same indication when one drug would be sufficient, prescribing “one tablet” for a drug available in more than one strength.

Table 11: The occurrence of each error scenario in the Psychiatric Ward for the months of April and May

Error Scenario	Number of Errors in April N=26 (n)	Number of Errors in May N=46 (n)
Prescribing a drug for a patient for whom, as a result of a co-existing clinical condition, the drug is contra-indicated	0	1
Not taking into account a potentially significant drug interaction	1	1
Prescription of a drug in a dose below that recommended for a patients clinical condition	0	5
Prescribing two drugs for the same indication when only one drug is necessary	1	1
Prescribing a dose or route that is not intended	3	1
Writing illegibly	3	2
Writing a drugs name using an abbreviation or other non-standard nomenclature	1	5
Writing an ambiguous medication order	7	18
Prescribing "one tablet" of a drug that is available in more than one strength of tablet	1	0
Omission of the route of administration for a drug that can be given by more than one route	3	3
Prescribing a drug to be given by intermittent intravenous infusion, without specifying the duration over which it is to be infused	0	1
Omission of the prescriber's signature	0	1
Transcribing a medication order incorrectly when re-writing a patient's drug chart	0	1
Prescribing a drug in a dose above the maximum dose recommended in the SAMF or data sheet	4	5
Misspelling a drug name	2	1

In the month of May, a total of 46 prescribing errors took place. The most frequently occurring of these scenarios were the writing of ambiguous medication orders (n=18), writing a drugs name using an abbreviation or other non-standard nomenclature (n=5),

prescribing a drug in a dose above the maximum dose recommended in the SAMF or data sheet (n=5) and under dosing of a drug (n=5). This was followed by 3 situations in which there was an omission of the route of administration of a drug and two situations of writing illegibly. There was only one occurrence of the following scenarios: prescribing two drugs for the same indication when only one drug is necessary, prescribing a dose or route that was not intended, prescribing a drug to be given by intermittent intravenous infusion without specifying the duration over which it is to be infused, omission of the prescriber's signature, misspelling a drug name and transcribing a medication order incorrectly when re-writing a patient's drug chart.

Overall for the entire ward over the 2 month period, the largest number of errors came in the form of ambiguously written medication orders which accounted for 35% of all the errors in this ward. The percentage contribution of each error scenario is illustrated in Figure 4. This was followed by prescribing a drug in a dose above the maximum dose recommended in the SAMF or data sheet accounting for 13% of all errors in this sample population. Thereafter 8% of errors in this sample for the two month period were attributed to writing a drugs name using an abbreviation or other non-standard nomenclature. Another 8% was also attributed to omissions of drug route of administration. In addition to this both under dosing of a drug and illegibility accounted for 7% each of the errors in this ward in the two month period. In addition, prescribing an unintended dose or route accounted for 6% of all errors, misspelling a drug name accounted for 4%, prescribing a clinical contraindicated drug accounted for 2%, not taking into an account an important drug interaction 3% and prescribing two drugs for the same indication accounted for 3%. The following error scenarios all accounted for 1% each for the prescribing errors in each

ward: prescribing of “one tablet” of a drug that was available in more than one strength, prescribing a drug to be given by intermittent intravenous infusion, without specifying the duration over which it is to be infused, signature omissions and transcribing errors when re-writing a patient's prescriptions.

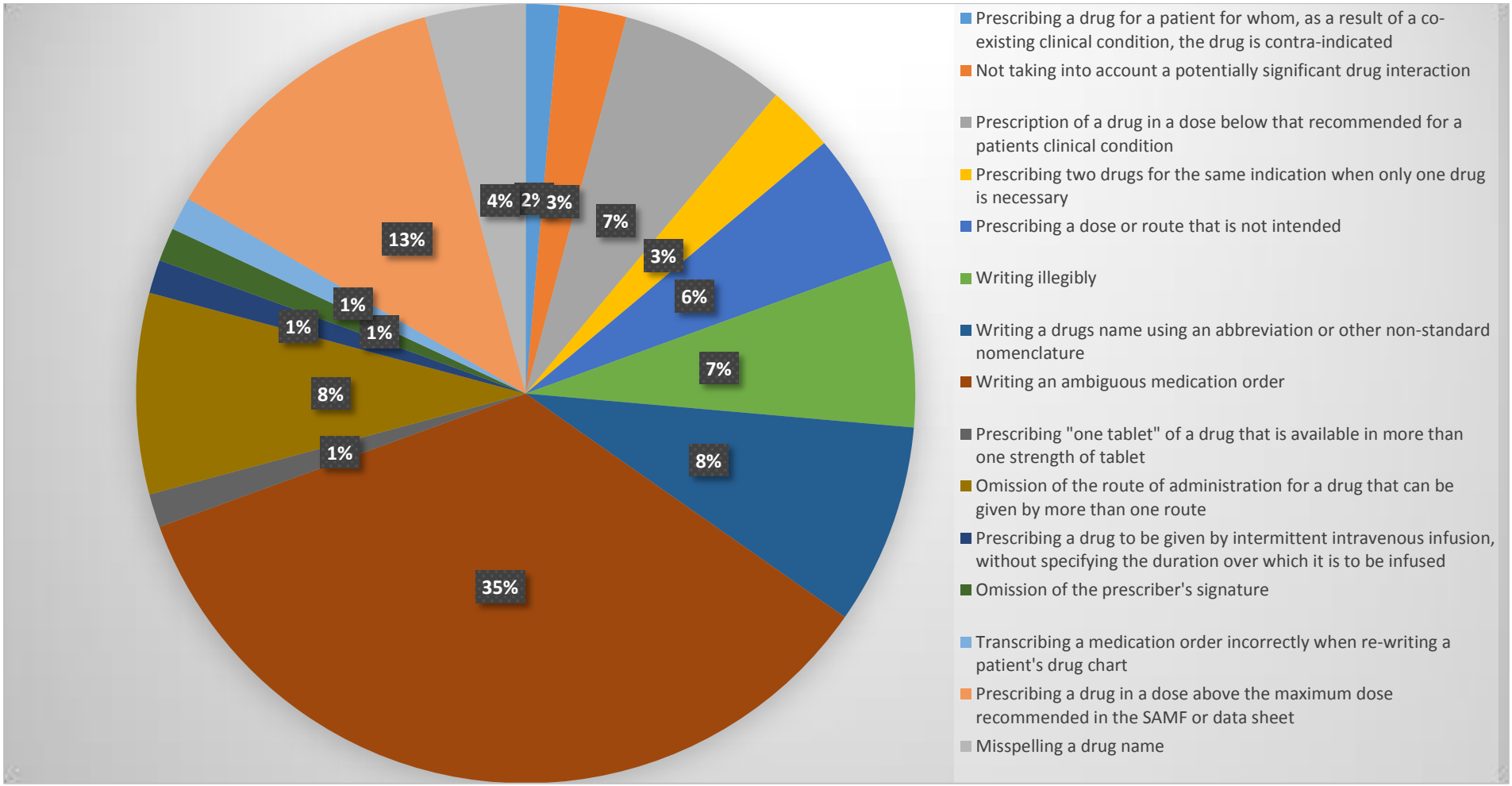

Figure 4: Percentage contribution of each error scenario in the Psychiatric Ward

4.8.4 Paediatric Ward

With the paediatric ward, the error scenarios differ from that of the adult wards and were classified according to the work done by Ghaleb *et al.,* (2005). Table 12 below outlines the scenario and the number of occurrences of each type of error depending on the month in the paediatric ward. In the month of April, there were a total of 64 prescribing errors that took place. The most frequent error scenarios that took place in the ward included: dosing errors (n=22), writing an ambiguous medication order (n=8), the prescription of a drug to a child without documenting the weight on the prescription sheet (n=7), prescribing a drug to a patient without adjusting for age (n=6) and omission of the prescribers signature (n=5). There were 3 instances of each of the following errors: prescribing a dose regimen not recommended for the formulation prescribed, prescribing a sub-therapeutic dose and prescribing a drug without adjusting for body size. There were two instances each of following scenarios: misspelling a drug name and prescribing a drug as necessary but not indicating the maximum dose. There was one instance of each of the following scenarios: writing illegibly and writing a drugs name using abbreviations or non-standard nomenclature and prescribing a drug to a patient without adjusting for renal insufficiency.

Table 12: The occurrence of each error scenario in the Paediatric Ward for the months of April and May

Error Scenario	Number of Errors in April N=64 (n)	Number of Errors in May N=82 (n)
Writing illegibly	1	4
Prescribing a drug to a child without documenting the weight on the prescription sheet	7	1
Prescribing a drug to a patient without adjusting for renal insufficiency	1	1
Misspelling a drug name	2	1
Prescribing a dose regimen (dose/frequency) that is not that recommended for the formulation prescribed	3	6
Writing an ambiguous drug order	8	17
Omission of the prescribers signature	5	4
Prescription of a drug in a potentially sub-therapeutic dose	3	1
Writing a drugs name using abbreviations or non-standard nomenclature	1	1
Prescribing a drug to a patient without adjusting for body size	3	6
Prescribing to a patient a dose that is not within the + or - 25% of the recommended dose	22	32
Prescribing a drug to a patient without adjusting for age	6	3
Prescribing a drug to be taken when required, without specifying the maximum dose of the drug prescribed in the participant	2	5

In the month of May, a total of 82 prescribing errors took place. The most frequently occurring of these scenarios were: dosing errors (n=32), ambiguous drug order (n=17), prescribing a drug to a patient without adjusting for body size (n=6), prescribing a dose regimen not recommended for the formulation prescribed (n=6) and prescribing a drug as necessary but not indicating the maximum dose (n=5). There were 3 instances of prescribing

a drug without adjusting for the child's age and 4 instances of omissions of the prescriber's signature. The following scenarios all occurred once each in the sample during the month of May: prescribing a drug to a child without documenting the weight on the prescription sheet, prescribing a drug to a patient without adjusting for renal insufficiency, misspelling a drug name, prescription of a drug in a potentially sub-therapeutic dose and writing a drugs name using abbreviations or non-standard nomenclature.

Over the two month period for the paediatric ward, dosing errors accounted for 37% of all errors on the ward. The percentage contribution of each error scenario is illustrated in Figure 5. This was followed by writing of ambiguous medication orders which accounts for 17% of all errors. Prescribing an incorrect dosage regimen, omission of a prescriber's signature, prescribing a drug without documenting a child's weight, prescribing a drug without adjusting for body size and prescribing without adjusting for age all account for 6% each of errors scenarios that occurred during the two month period on the ward. Over April and May, writing a prescription for a drug that was meant to be taken when necessary without specifying the maximum daily dose accounted for approximated 5% of the errors in this ward. Writing illegibly accounted for approximately 4% of all errors and this was followed by sub-therapeutic dosage prescribing which account for 3% of all errors on this ward and misspelling of a drug name which accounted for 2% of all errors respectively. Prescribing without adjusting for renal function and using non-standard nomenclature accounted for 1% each of the errors that occurred on this ward.

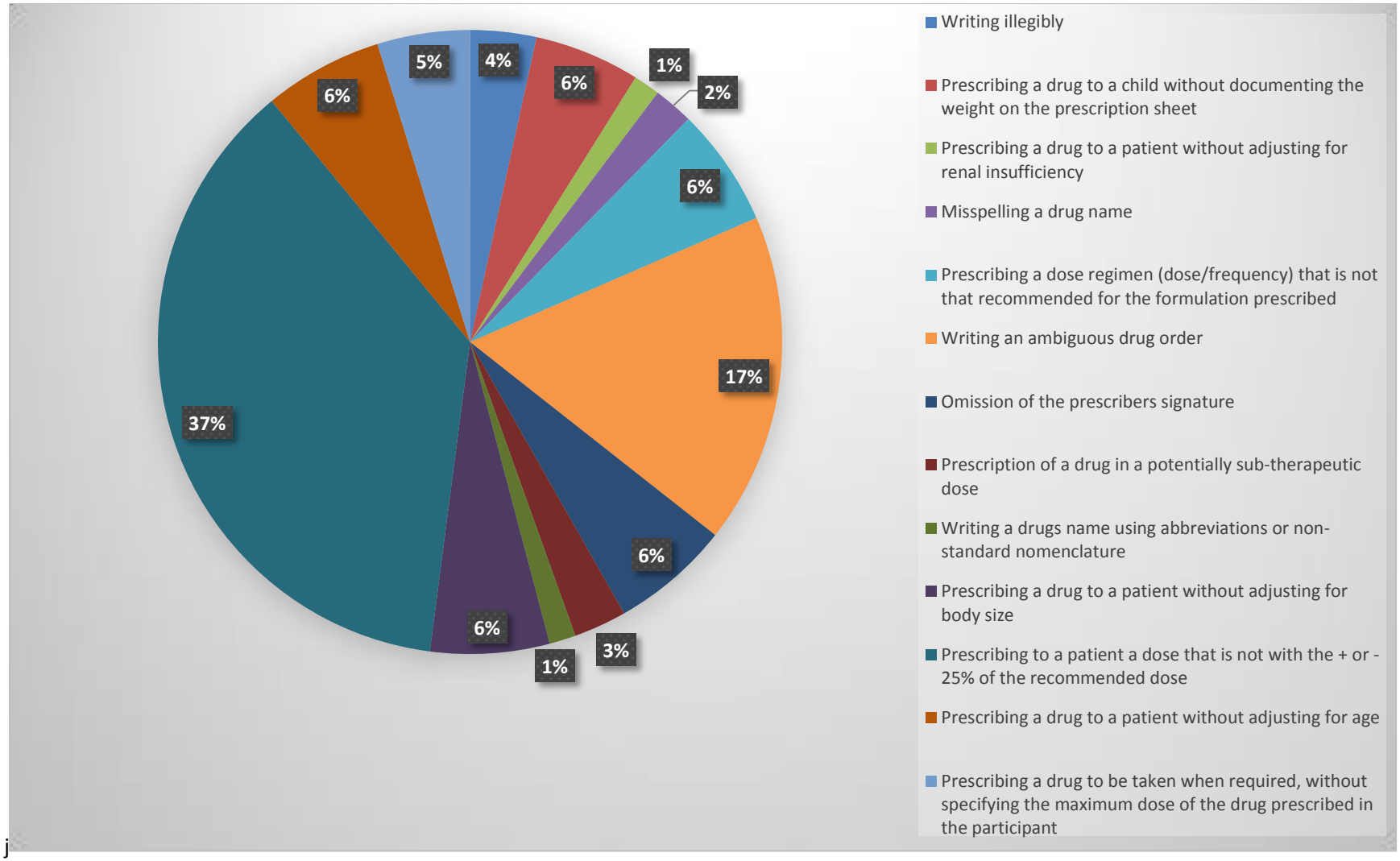

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Figure 5: Percentage contribution of each error scenario in the Paediatric Ward

4.9 Multinomial Logistic Regression

To compare the four wards to one another multinomial logistic regression was utilized. Table 13 shows the results of multinomial logistic regression analysis of the prescription data that was collected during the sample period.

Table 13: Multinomial logistic regression of the prescription data

Total Errors	Coefficient	Robust Standard Error	P-Value	[95% Confidence Interval]	
0	(base outcome)				
1					
Ward					
Med ward	0	(base)			
Surg ward	-0.5294054	0.2179646	0.015	-0.9566081	-0.1022026
Pysch ward	-0.8505819	0.2074561	0.000	-1.257188	-0.4439755
Paeds ward	0.3815245	0.1499035	0.011	0.0877191	0.6753298
_cons	-1.541609	0.0997821	0.000	-1.737178	-1.34604
2					
Ward					
Med ward	0	(base)			
Surg ward	-0.2252093	0.6711937	0.737	-1.540725	1.090306
Pysch ward	1.032129	0.4221205	0.014	0.2047883	1.85947
Paeds ward	1.106816	0.4223843	0.009	0.2789583	1.934674
_cons	-4.148271	0.3360001	0.000	-4.806819	-3.489723
3					
Ward					
Med ward	0	(base)			
Surg ward	-0.085915	0.0806336	0.287	-0.243954	0.0721239
Pysch ward	14.04237	1.002666	0.000	12.07718	16.00756
Paeds ward	15.21555	0.5817593	0.000	14.07532	16.35577
_cons	-19.93124	0.0476513	0.000	-20.02464	-19.83785
4					
Ward					
Med ward	0	(base)			
Surg ward	-0.085915	0.0771152	0.265	-0.2370579	0.0652279
Pysch ward	15.42886	1.002379	0.000	13.46423	17.39349
Paeds ward	0.0724209	0.0684998	0.290	-0.0618361	0.206678
_cons	-21.31754	0.042522	0.000	-21.40088	-21.2342

Using a base outcome of 0 total errors and base of the medical ward that was equal to zero. For total number of errors equal to 1, when compared to the medical ward, the co-efficient from the multinomial logistic regression for the surgical ward was -0.53 ($p<0.05$, 95%CI -0.96 to -0.10). The robust standard error was 0.12. For the psychiatric ward the coefficient was -0.85 ($p<0.01$, 95%CI -1.26 to -0.44) with a robust standard error of 0.08. When compared to the medical ward, the paediatric ward had a coefficient of 0.38 ($p<0.05$ 95%CI 0.09 to 0.68) and a robust standard error of 0.22.

For total number of errors equal to 2, when compared to the medical ward the co-efficient from multinomial logistic regression for the surgical ward was -0.23 ($p>0.05$, 95% CI -1.54 to 1.09). The robust standard error was 0.67. When comparing the psychiatric ward to the medical ward the coefficient was 1.03 ($p>0.05$, 95%CI 0.20 to 1.86) with a robust standard error of 0.42. For the paediatric ward, the coefficient was 1.10 ($p<0.01$ 95%CI 0.28 to 1.93) with a robust standard error of 0.42.

For total number of errors equal to 3, when compared to the medical ward the co-efficient from multinomial logistic regression for the surgical ward was -0.08 ($p>0.05$, 95% CI -0.24 to 0.07). The robust standard error was 0.08. When comparing the psychiatric ward to the medical ward using multinomial logistic regression the coefficient was 14.04 ($p<0.01$, 95%CI 12.07 to 16.00) with a robust standard error of 1.00. For the paediatric ward, the coefficient was 15.21 ($p<0.01$ 95%CI 14.07 to 16.35) with a robust standard error of 0.58.

Lastly, for prescriptions containing four errors, when compared to the medical ward the co-efficient from multinomial logistic regression for the surgical ward was -0.08 ($p>0.05$, 95% CI -0.24 to 0.07). The robust standard error was 0.08. When comparing the psychiatric ward to the medical ward using multinomial logistic regression the coefficient was 15.42 ($p<0.01$,

95%CI 13.46 to 17.39) with a robust standard error of 1.00. For the paediatric ward, the coefficient was 0.07 (p>0.05, 95%CI -0.06 to 0.20) with a robust standard error of 0.07.

4.10 Relative Risk Ratio

Relative risk ratios were chosen to compare the data using interferential statistics. The relative risk analysis was used to determine what the risk was of having a prescription with one or more errors on it depending on which ward a patient was admitted to in the teaching hospital. Using no errors or 0 errors as a base outcome and the medical ward as a base of one for comparison, the surgical ward, psychiatric ward and paediatric ward were compared. Table 14 shows the results of relative risk ratio analysis of the prescription data that was collected during the sample period.

Table 14: Relative risk ratio analysis of the prescription data that was collected

Total Errors	Relative Risk Ratio	Robust Standard Error	P-Value	[95% Confidence Interval]	
0	(base outcome)				
1					
Ward					
Med ward	1	(base)			
Surg ward	0.5889551	0.1283714	0.015	0.3841938	0.9028466
Pysch ward	0.4271663	0.0886182	0.000	0.2844527	0.6414811
Paeds ward	1.464515	0.2195359	0.011	1.091681	1.964681
_cons	0.2140364	0.021357	0.000	0.1760164	0.2602689
2					
Ward					
Med ward	1	(base)			
Surg ward	0.7983491	0.5358469	0.737	0.2142258	2.975185
Pysch ward	2.807037	1.184908	0.014	1.227265	6.420335
Paeds ward	3.024713	1.277592	0.009	1.321752	6.92179
_cons	0.0157917	0.005306	0.000	0.0081738	0.0305093
3					
Ward					
Med ward	1	(base)			
Surg ward	0.9176722	0.0739952	0.287	0.7835237	1.074789
Pysch ward	1254655	1258000	0.000	175814.2	8953546
Paeds ward	4055342	2359233	0.000	1296681	1.27e+07
_cons	2.21e-09	1.05e-10	0.000	2.01e-09	2.42e-09
4					
Ward					
Med ward	1	(base)			
Surg ward	.9176722	0.0707664	0.265	0.7889456	1.067402
Pysch ward	5019597	5031541	0.000	703788.1	3.58e+07
Paeds ward	1.075108	0.0736446	0.290	0.9400369	1.229587
_cons	5.52e-10	2.35e-11	0.000	5.08e-10	6.00e-10

For the prescriptions with one error, the relative risk ratio for the surgical ward was 0.58 ($p<0.05$, 95%Cl 0.38-0.90). For the psychiatric ward the relative risk ratio was 0.43 ($p<0.01$, 95%Cl 0.28-0.64) and the relative risk ration for the paediatric ward was 1.46 ($p<0.05$, 95%Cl 1.09-1.96).

For the prescriptions containing two errors, the relative risk ratio for the surgical ward was 0.79 ($p>0.05$, 95%Cl 0.21-2.98). For the psychiatric ward the relative risk ratio was 2.80 ($p<0.05$, 95%Cl 1.23-6.42 and the relative risk ratio for paediatric ward was 3.02 ($p<0.01$, 95%Cl 1.32-6.92).

For prescriptions containing three errors, the relative risk ratio for the surgical ward was 0.92 ($p>0.05$, 95%Cl 0.78-1.07). For the psychiatric ward the relative ratio when three errors were found on a prescription was 1254655 ($p<0.01$, 95%CI 175814.2-8953546). For the paediatric ward the relative risk ratio was 4055342 ($p<0.01$, 95%CI 1296681- 1.27e+07).

Lastly, for prescriptions containing four errors, the relative risk ratio for the surgical ward was 0.91 ($p>0.05$, 95%Cl 0.78-1.07), whilst the relative risk ratio for the psychiatric ward was 5019597 ($p<0.01$, 95%CI 703788.1-3.58e+07). The relative risk ratio for the paediatric ward was 1.07 ($p>0.05$, 95%CI 0.94-1.23).

CHAPTER 5: DISCUSSION OF PRESCRIPTION DATA REVIEW

5.1 General Adult Percentage Prescribing Errors

We expected that our percentage prescribing error would be higher than most international studies. The rationale for this was that this study was both conducted in a developing country and that it was a retrospective analysis of patient records. As Franklin et al., (2009) noted that when comparing methodologies for collecting prescription error data, a retrospective analysis of records found a higher number of errors and a higher percentage error than a prospective analysis. Ferner (2009) also noted that a retrospective review of patient records was consistent with a study conducted by pharmacist and gives a more complete understanding of medication errors

In our study, of the 1383 prescriptions written for the adult population, there were 248 prescribing errors noted with a percentage prescribing error of 17.9%. The adult prescribing error percentage in our hospital is higher than the percentage noted by Franklin *et al.,* (2010) in her systematic review. Franklin *et al.,* (2010) reviewed the studies conducted in the United Kingdom and noted the median error rate was 9.9% and ranged from 7.7-14.6%. The adult prescribing error percentage noted in our study was also higher than the percentage reported by Dean *et al.,* (2002) of 1.5% in the United Kingdom and. the percentage error rate reported in the United States of 6.5% (Lesar *et al.,* 1997; Bobb *et al.,* 2004). The percentage error of in this hospital was also higher than the median error rate of 7% as described by Lewis *et al.,* (2009) who reviewed studies conducted around the world.

This percentage error was also higher than the mean percentage error reported by Franklin et *al.,* (2011) Ashcroft *et al.,* (2015) and Ryan *et al.,* (2014) who investigated prescribing errors in multiple hospitals in the United Kingdom. One has to understand, however, that

these studies examined prescribing errors through a multi-centre approach as opposed to our study where we examined prescribing errors at a single academic teaching hospital. Our study was only conducted in an academic teaching hospital which also means that there is active learning of prescribing processes going on it and thus this could also explain the higher percentage prescribing error rate. Furthermore, this fits with the study by Ryan et al., (2014) who suggested that designated teaching hospitals have a higher percentage prescribing error rate.

The percentage prescribing error of 17.9% noted in this study was, however, lower than the percentage error that was reported by Seden *et al.,* (2013) who after looked at nine hospitals in North-West England that the error rate was 48.3% of all prescriptions written. This number ranged between 20% and 60% per hospital, also putting the prescribing error percentage to be smaller in this study than what was reported in the hospital with the least number of errors. Whilst Seden *et al.,* (2013) also used the same definition as our study; they were looking to adjudicate whether or not the grade of the prescriber (junior doctor vs senior doctor) resulted in them being more likely to commit a prescribing error and furthermore the study did not separate out adequately the adult and paediatric population, and thus direct comparison with our study is very difficult because of the differences in methodology and the lack of differentiation between the adult and paediatric population.

When comparing the results of this study to the study of Pote *et al.,* (2007) who investigated prescribing error in India, the percentage prescribing error was lower than that reported by Pote *et al.,* (2007). One cannot, however, draw any true comparison between our study and this study as they have used difference definitions and methodology which Lewis *et al.,* (2009) points to as a reason for variability in the results of such studies. In the case of Pote

et al., (2007), the study was setup to first identify medication errors and then put the prescription through software to identify any potential drug-drug interactions. This does not take into account the possibility that said drug-drug interactions are not clinically relevant and whether or not they were accounted for by the prescriber of the medication.

For the most part, our expectation that prescribing error percentage in the adult population would be higher than previous studies published on the subject was proven to be correct and where this was not the case it could be explained though fundamental differences in the methodologies of the studies.

5.2 General Paediatric Prescribing error percentage

With paediatric prescribing error percentage we expected our rate to be higher than that of other published studies. Ghaleb *et al.,* (2010) was the first to conduct a multi-centre paediatric prescribing error study in the United Kingdom and as a result of this, it is the primary study to draw comparisons from with regards to the United Kingdom. The prospective study was conducted in three different hospital paediatric in patient wards in the United Kingdom. Ghaleb *et al.,* (2010) was the first study to use the definitions for paediatric prescribing and scenarios that we used in our study and the percentage error rate as calculated was 13.2% of all prescriptions written with highest percentage error in one hospital being 31.5%.

In our study, there were 459 prescriptions written in the paediatric ward, of which a total of 146 errors took place over the two month period with a corresponding error rate of 31.8% and this is higher than the percentage error that was described by Ghaleb *et al.,* (2010). Furthermore, when taking into account the variation of different wards that were included

in the study by Ghaleb *et al.,* (2010), the paediatric prescribing error percentage in this ward is similar to the maximum percentage described in their study (31.8% vs 31.5%). Different data collectors were used in the study by Ghaleb *et al.,* (2010) leading to the variability in the percentage prescribing error rates that were reported. This could indicate that we collected data in a similar way to that of one of their data collectors who collected the data from the hospital with the 31.5% prescribing error rate. It is likely that our study which took place in one ward and one hospital with a smaller prescription sample could account for the higher percentage error rate, in the same way that one hospital included in the study had as high a percentage error rate as we did.

Furthermore, the percentage error rate in our study is similar to the number reported by Potts *et al.,* (2004) but higher than the percentage error rate reported by Fontan *et al.,* (2003) and Kaushal *et al.,* (2001). Both Potts *et al.,* (2004) and Fontan *et al.,* (2003) also used broaden definitions for errors. One has to understand that despite these broader definitions, they were not exactly the same as those defined by Ghaleb *et al.,* (2005) and thus direct comparison of these studies results to that of our study is not possible.

The percentage error in our study was also higher than the 14.8% noted by Condren *et al.,* (2014) who performed a prospective analysis on paediatric prescription data in the United States. A possible reason why the paediatric percentage error in this hospital might be higher than most of the international studies that it has been compared to above, is because that this was a retrospective analysis of records and not a prospective data collection process.

The 31.8% in our study was however lower than the percentage that was reported by Gokhul *et al.,* (2016) which is currently the only published local comparator for our study.

There are some importance differences between our study and the one conducted by Gokhul *et al.,* (2016). The study by Gokhul *et al.,* (2016) asked members of staff on the ward to spontaneously report prescribing errors and also investigated errors by independent chart review by pharmacists whilst ours was by retrospective analysis of patient records with consensus of error judged by our team of experienced professionals. Their denominators for the calculating prescribing errors were also different from our methodology as was their setting (a paediatric ICU). The methodology used in our study took into account all prescriptions written on the ward for the time period under study and not just the total of all prescribing and administration errors. As a result of this our denominator was much larger than that of Gokhul *et al.,* (2016) and this lead to our small percentage prescribing error rate.

Thus our paediatric prescribing error percentage was higher than or equal to most quoted studies provided the method for calculating the numerator or denominator calculation was similar to those used in our study and the definitions were broad enough.

5.3 April vs May in Terms of Prescribing Errors

Dean *et al.,* (2002a) noted that different times of the year might lead to less or more prescribing errors, but this was not substantiated by the data in our study. As the data shows there were more prescriptions collected for the month of May than the month of April. This could be due to the number of public holidays in April which were more than in the month of May. With the increased number of public holidays there are unlikely to be as many changes to patients prescriptions and thus prescriptions are continued for a longer periods of time because only skeleton staff is available on the wards. However, the Fisher's exact test showed that ($p=0.286$) there was no statistically significant difference between

the months for all the wards in terms of the total number of errors. Thus, the numbers of errors on prescriptions were generally consistent for the period of time the study took place despite there being more prescribing errors in May than in April.

5.4 Adults vs Paediatric Prescribing Error

Kaushal *et al.,* (2001) posited that paediatric medication errors were far more frequent than adult medication errors. Miller *et al.,* (2007) also noted the increased risk of the paediatric population to prescribing errors. Ghaleb *et al.,* (2010) reported that the prescribing error rate described in their study was higher than the known figure for the adult prescribing error rate at that time. To our knowledge, there have been no published studies that compared adult to paediatric prescribing errors within the same hospital using the definitions and scenarios of Dean *et al.,* (2000) and Ghaleb *et al.,* (2005). In our study, 248 prescribing errors took place in the adult population and 130 prescribing errors took place in the paediatric population, the prescribing error percentage in adults was 17.93% and the prescribing error percentage for paediatrics was 31.80%. There was a statistically significant difference between the errors of adults and paediatrics with $p<0.01$. This help confirms that errors in paediatrics are more frequent than errors than in the adult population. Ghaleb *et al.,* (2010); Levine *et al.,* (2001) and Standing *et al.,* (2005) noted that paediatric patients have different pharmacokinetic, pharmacodynamics and toxicological profiles depending on their ages and stage of development. Thus, in paediatrics the importance of calculating the dose of the medication cannot be understated, something that is not as important in the general adult population (Ghaleb *et al.,* 2010; Levine *et al.,* 2001; Standing *et al.,* 2005). Gokhul *et al.,* (2016) noted the difficulty that staff on the paediatric ward had with

calculating prescribing errors and thus could potentially lead to a larger number of calculation related errors leading to an increase in the total number of errors.

5.5 Medical Ward

We expected the prescribing error rate to be higher in our medical ward than most international studies. Franklin *et al.,* (2011) through a multi-centre, multi-ward study showed that the percentage prescribing error for the medical wards included in the study was 16.3% based on 4059 prescriptions that were prospectively screened. Franklin *et al.,* (2011) was the first study to compare two different kinds of wards to each other i.e. a medical and surgical ward and their methodology including definitions and scenarios for errors were the as the ones used in this study. In our study, 701 prescriptions were reviewed in the medical ward of which 140 prescribing errors were found on these prescriptions, leading to a percentage prescribing error of 19.97%. The most probable reasons for the higher percentage prescribing error in our study was because Franklin *et al.,* (2011) performed a prospective analysis of patient prescriptions in multiple medical wards in multiple hospitals, while our study was a retrospective analysis of patient charts and we only examined data from one medical ward in one hospital. The study by Franklin *et al.,* (2011) was chosen for direct comparison because it separated it reported the data for the medical and surgical ward separately before comparing the two wards to each other. Furthermore, the percentage errors that we reported in our study could also be higher because the hospital that we chose was a teaching hospital. As Ryan *et al.,* (2014) noted designated teaching hospital or in our setting academic teaching hospitals are associated with higher error rates than other hospital.

We expected to have similar findings like other studies where either dosing errors or medicine omission related errors would be the highest errors. This was not the case. The scenarios that accounted for the most number of errors in our sample are detailed in Figure 2 in Chapter 4. In comparison with other studies (Franklin *et al.,* 2007; Franklin *et al.,* 2011; Pote *et al.,* 2007; Ryan *et al.,* 2014; Barber *et al.,* 2003) the most frequently occurring error scenario in our medical ward was unsigned prescriptions which accounted for 35% of all errors on this ward. In other studies the largest number of errors was medical omissions from a patient's prescription (Franklin *et al.,* 2011; Ryan *et al.,* 2014). When looking specifically at unsigned prescriptions Ryan *et al.,* (2014) makes mention of it as an error that accounted for an overall 2.6% of all prescriptions sampled in that study. Ryan and colleagues (2014) also broke this 2.6% down and found that in an academic teaching hospital unsigned prescriptions accounted for approximately 1.8% of all the errors investigated. This meant that unsigned prescriptions were more frequent in academic teaching hospitals than other hospitals. The reason behind there being such a large number of unsigned prescriptions in our study, maybe due to a system problem and will be discussed further in the next chapter.

The largest number of errors noted by Barber *et al.*, (2003) was dosage related errors (54% of all errors) which only account for 3% of all errors within our sample medical ward over the two month period. Franklin *et al.,* (2007) also noted that 48.4% of all errors were caused by dosing errors and Pote *et al.,* (2007) noted that dosing errors accounted for 9.6%. Thus, the number of dosing related errors in the sample medical ward investigated is lower than in all these international studies. This was probably due to the nature of the study in that prescribers had an opportunity to correct dosing errors on their ward rounds and also probably had assistance from the nurses on their wards to ensure the doses were correct

and not perpetuate these errors. Since the prescriptions were not collected prospectively we collected prescriptions as written in their final form, not their original form. Thus, if a prescriber made additions or changes to a prescription it would be impossible for us to know that such changes were made.

Prescribing two drugs for the same indication or duplicate prescribing accounted for 1% of all errors in this sample, this lower than the 4.6% of errors described by Ryan *et al.,* (2014) and approximately equal to the percentage described by Franklin *et al.,* (2011). It was also lower than the 4.9% described by Franklin *et al.,* (2007) with regards to this type of error. It was also lower than the 11.3% reported by Gethins *et al.,*(1996).

The second most frequently occurring error in our medical ward was the writing of ambiguous medication orders (prescriptions), which accounted for 15% of all errors. No mention of ambiguous medication orders was made by either Franklin *et al.,* (2011); Ryan *et al.,* (2014); Pote *et al.,* (2007) or Franklin et al., (2007). It is likely that ambiguous medication orders were not noted in the overseas studies because ward pharmacists were used to collect the prescription data and they would likely know how the prescribers in their respective wards wrote their prescriptions and thus would be able to identify and correct ambiguous medication orders.

When looking at illegible prescriptions, the 6% in our study is much higher than the percentage described by Franklin *et al.,* (2011). It is also higher than the 2% described by Ryan *et al.,* (2014). It is likely that the lower number of illegible prescriptions in the other studies were due to the fact that ward pharmacists were used to collect these prescriptions and were able to clarify with prescribers before designating prescriptions as illegible. In contrast our figure of 6%, illegible prescriptions in the region of 10% have been reported in

other studies (Ho *et al.,* 1992; Paul *et al.,* 2015). Illegible prescriptions are a potential cause of patient harm (Albarrak *et al.,* 2014; Brits *et al.,* 2017; Winslow *et al.,* 1997). These prescriptions increase the risk of dispensing errors and administration errors regardless of their lack of completeness or accuracy of the information recorded on them (Albarrak *et al.,* 2014). Thus having a higher number than some international studies is a potential cause for concern. The methodology of determining illegibility in our study was that photographic evidence of illegibility was taken and shown to the consensus committee. If the members of the committee were unable to read the prescriptions then it was considered illegible. One of the members on the committee was an expert pharmacist whom Albarrak *et al.,* (2014) maintained only found 2% of all prescriptions illegible. Furthermore, another member of the committee was a physician whom Brits *et al.,* (2017) noted were more likely than nurses or pharmacists to be able to read illegible prescriptions. Thus, the prescriptions in our study that were considered illegible, were mostly likely illegible.

Using of non-standard nomenclature and abbreviations accounted for 5% of all errors in this ward. This number is higher than the number described from medical ward admission as investigated by Franklin *et al.,* (2011). The 5% is also higher than the amount described by Ryan *et al.,* (2014) who noted that this occurred in 4.4% of all prescriptions that were sampled. It is worth pointing out, however, that even though this number is higher, the sample size used by Ryan *et al.,* (2014) was much larger than the sample utilized from this medical ward. This is, however, considerably lower than the 66% described by Gethins *et al.,* (1996) and the 12.5% described by Lustig et al., (2000). The number from our study was similar to a South African study on antiretroviral prescribing errors by Malangu and Nchabeleng (2012). The use of such non-standard nomenclature and abbreviations are

potential cause of patient harm as a result of a medication error (Brits *et al.,* 2017). Brits et al., (2017) also noted that doctors often committed the errors of using non-standard abbreviations (60% of cases noted) despite the fact that doctors are reminded that no drug name should be abbreviated. Thus, while our number was lower than the reported number by Brits *et al.,* (2017), the problem in our ward is not an isolated incident in South Africa.

When looking at the combination of the lack of information regarding the dose strength (12%) as well as clinically important omissions of routes of administrations (6%), this occurred 18% of the prescriptions in our medical ward. Ryan *et al.,* (2014) noted that it occurred in only 2.6% of all prescriptions sampled and almost negligibly in the study by Franklin *et al.,* (2011). Furthermore, the 18% from our ward was higher than the amount described by Franklin et al., (2007) who noted this type of error occurred in 10.8% of their sample. The findings in our ward are probably higher because all our prescriptions were handwritten, while the other studies also included computer generated prescriptions. Albarrak et al., (2014) noted that handwritten prescriptions were more likely to lack dosing and route of administration related information than computer generated prescriptions.

Dosing errors that took place in the medical ward for the sample period accounted for 4% of all errors. When breaking that number down, sub-therapeutic or underdosing accounted for 3% of all errors while supra therapeutic or overdosing errors accounted for 1% of the errors in our ward. This number was similar to the number described by Franklin *et al.,* (2011) but lower than the dosing error percentage described by Franklin *et al.,* (2007). Both of these studies did not differentiate between sub-therapeutic doses and supra-therapeutic doses. The medical ward sampled in our study was lower than that described by Pote *et al.,* (2007). Similarly it was lower than the numbers described by Ryan *et al.,* (2014) of 7.8% (sub

therapeutic dosing) and 5.1% (supra-therapeutic dosing). The dosage errors in this medical ward sample were also lower than that reported by Barber *et al.,* (2003). Pote *et al.,* (2007) described underdosing as occurring 2.6% of the errors while overdosing was reported in 7% of all errors. The most probable reason for the lower number of dosage errors could be that the data in our study was collected retrospectively (compared to all the studies mentioned above where data was prospectively collected or in "real time") as such dosage errors would often have been corrected during the patient's stay in the hospital.

5.6 Surgical Ward

There are no local studies in surgical wards that can be used to compare the data from our ward to and thus one must examine to internationally studies particularly in the United Kingdom as comparators. We expected, however, our surgical ward to have a higher prescribing error percentage than international studies. There are also very few studies that adequately separate out the data from both the medical and surgical ward and instead chose to present the data as one figure e.g. Ryan *et al*., (2014); Seden *et al*., (2013) but the first study to do this was Franklin *et al.,* (2011) and thus it is the main study we have used for comparison. In the surgical ward over the two month period, there were 36 prescribing errors in 271 prescriptions; with a total percentage error rate of 13.28%. This was higher than the 12.2 % that was reported in the study by (Franklin *et al*., 2011). The percentage error rate in our study was lower than the percentage error that was reported by Seden *et al.,* (2013) but the data as we suggested above was not differentiated with regards to different wards and thus direct comparisons are difficult to draw. Similar to the data presented by Franklin *et al*., (2011), the percentage error in our surgical ward (13.28%) was lower than that of our medical ward (19.97%). Another similarity between our study and the

study by Franklin *et al.*, (2011), was that there were fewer prescriptions reviewed in the study time period in the surgical ward when compared to the medical ward. In our study, there were 701 written prescriptions in the medical ward and 271 in the surgical ward. The error percentage of 13.28% did, however, fall within the 95% CI reported by Franklin *et al.*, (2011) of 10.9% - 13.5%. This means that the data from our surgical ward was close to the upper limit of the 95% CI reported by Franklin *et al.,* (2011).

When examining the information regarding the error scenarios in the surgical ward, the highest contribution comes from ambiguous medication orders (23%). There is no mention by Franklin *et al.,* (2011) of ambiguous medication orders in the sample, and instead, the highest errors in their sample were due to inappropriate dosing. However, in our sample, there were no cases of inappropriate dosing. Inappropriate dosing schedules on the other hand, which accounted for approximately 1% of all errors in the sample by Franklin *et al.,* (2011), accounted for 14% of all error in our surgical ward. There were no cases of unsigned prescription in the sample by Franklin *et al.,* (2011) but this accounted for 9% of all errors on the ward, in the sample or in the surgical ward that was included in this study. Illegible prescriptions accounted for, roughly, 1% of all errors in the surgical wards investigated by Franklin *et al.,* (2011), but this accounted for only 6% of all errors in our sample of the surgical ward. Incorrect or inappropriate abbreviations accounted for 6% of all errors in our surgical ward and this was higher than the percentage that was reported by Franklin *et al.,* (2011).

Thus the percentage error rate in our surgical ward was higher than the published international study but was close to the upper limit of the 95%CI interval that was reported. Given that our study took place both prospectively and in an academic teaching hospital this

could account for the higher rates. Whilst some scenarios that we found on our ward were different from other international studies, some were similar.

5.7 Psychiatric ward

To our best knowledge, there have been no such studies conducted in psychiatry wards in South Africa, and thus we don't have local data to compare this study to. The psychiatric ward included in our study accounted for 72 prescribing errors in the two month period. Thus, with a total of 361 prescriptions, the percentage error rate was 17.48%. This number is higher than the percentage reported by Stubbs *et al.,* (2006) and is also higher than the percentage error rate of 6.3% reported by Keers *et al.,* (2014). The numbers reported in both these studies were taken from multi-centre studies in the United Kingdom. Bowers *et al.,* (2008) with a similar methodology and also looked at an inpatient psychiatric ward, found that prescribing error percentage to be 23%. Thus, the value of 17.48% in this study is lower than the percentage that was reported by Bowers *et al.,* (2008) was a prospective study, which could explain the higher percentage error.

Over the two month period, the most frequently occurring error scenario was ambiguous medication orders (35%). This was higher than the 2.7% that was reported by Stubbs *et al.,* (2006) and higher than the 6.28% that was reported by Bower *et al.,* (2008). A similar find regarding a large number of ambiguous prescriptions in psychiatric wards was also found by Birmingham *et al.,* (1999), Geffen *et al.,* (2002) and Harrington *et al.,* (2002). Similar to these studies we also found this to be the case with PRN (when necessary) prescriptions. These errors are considered unintentional clerical errors (Paton and Gill-Banham, 2003). These situations as Harrington *et al.,* (2002) noted left nurses with the responsibility of deciding when to give the patients medicines and could lead to medicine being administered above

the maximum dose of the medicine prescribed. Supra therapeutic doses or doses above the maximum suggest doses accounted for 15% of all errors. These errors were not reported by Stubbs *et al.,* (2006), Bowers *et al.,* (2008) or Keers *et al.,* (2014) but again were found in psychiatric wards studied by Birmingham *et al.,* (1999), Geffen *et al.,* (2002) and Harrington *et al.,* (2002). The 8% of errors attributed to use of abbreviation for drug names or non-standard nomenclature is higher than the 0.4% that was reported by Stubbs *et al.,* (2006). Such situations as we noted before could lead to patient harm if they are not interpreted correctly. Additionally, another 8% of errors were attributed to the omission of the route of administration. This was higher than the 1.5% that Stubbs *et al,* (2006) reported and also higher than the number reported by Bowers *et al,* (2008). Illegible prescriptions accounted for 7.9% in this sample. It was higher than the 1.5% reported by Stubbs *et al.,* (2006). It was also higher than the number that was reported by Bowers *et al.,* (2008).

Under dosing of drugs prescribed (7%) was also higher than other reported studies such as Stubbs *et al.,* (2008). However, this number was similar to the 6.94% that was reported by Keers *et al.,* (2014). Thus, this study and Keers *et al.,* (2014) found a similar amount of under dosed medications. Prescription of an unintended dose or route accounted for 6% in the Johannesburg teaching hospital. This was higher than the 4.4% recorded by Stubbs *et al.,* (2006). The number of hospitals included by Stubbs *et al.,* (2006), could possibly be the reason for the smaller number of this reported error. No reports of such an error were made by Keers *et al.,* (2014). These errors have been linked to a lack of understanding of medicines that are being prescribed (Paton and Gill-Banham, 2003).

Misspelling of a drug name, which accounted for 4%, was higher than 0.8% reported by Stubbs *et al.,* (2006). No reports of such an error were made by Bowers *et al.,* (2008), who

did not look at clinical specific errors and thus there is no comparison that could be made. The 2% of errors accounted for by prescribing clinically contraindicated drugs was higher than the 0.8% reported by Stubbs *et al.,* (2006). This number was also higher than the number reported by Keers *et al.,* (2014) who only reported 4 such errors out of 288 (1.33%). Only 3 errors out of 159 (1.89%) were accounted for by the same error scenario as reported by Bowers *et al.,* (2008). Thus, this is similar to the number reported by Bowers *et al.,* (2008) in their study of just one psychiatric was due to drug-drug interactions is higher than that reported by Bowers *et al.,* (2008), as there were no reports of drug interactions 1.1% of errors reported by Stubbs *et al.,* (2006) was due to drug-drug interactions, again making the percentage in our study hospital higher. One of the dominant drug interactions that we noticed was the concomitant prescribing of NSAIDs and Lithium, which Paton and Gill-Banham (2003) suggested could lead to lithium toxicity. This points to what Paton and Gill-Banham (2003) described as a lack of drug knowledge which leads to the writing of a prescription with drug-drug interactions. There was only one report of prescribing two drugs for the same indication (Bowers *et al,* 2008). In addition to that, this 3% was also higher was 1.7% reported by Stubbs *et al.,* (2006).

Whilst omission of the prescriber's signature accounted for only 1% of all errors in our study, other studies in psychiatric wards have shown this to be one of the most frequently occurring errors. There were 68 cases of unsigned prescription reported by Stubbs *et al.,* (2006), 13% of all errors. The 1% reported in our study is also lower than the 9% reported by Keers *et al.,* (2014), and the 76.1% reported by Bowers *et al*., (2008). This could point to higher levels of accountability in our psychiatric ward, with prescribers being the ones who actually write patient prescriptions and perhaps have their prescriptions transcribed by

nurses. This could also make feedback to prescribers much easier since they could be easily identified and spoken to when a prescribing error occurs (Keers *et al.,* 2014).

Transcribing a patient's prescription incorrectly which accounted for 1% of error in our study was lower than 3.3% reported by Stubbs *et al.,* (2008). This could indicate better communication between staff members on this ward regarding drug information (Keers *et al.,* 2014). Prescribing one tablet of a drug that is available in more than one strength without specifying the strength was 1% in the sample. This number was lower than the 3.6% reported by Stubbs *et al.,* (2006) but higher than the percentage reported by Bowers *et al.,* (2008).

5.8 Comparing all Three Adult Wards

Within the sample, the medical ward had the highest percentage error of 19.97%, followed by the psychiatric ward with 17.48% and the lowest percentage error was noted in the surgical ward which was 13.28%. Similar to the study conducted by Franklin *et al.,* (2011) who compared medical wards to surgical wards, the medical wards had the higher percentage error. No studies have compared the percentage error rates of the medial wards to psychiatric wards within the same hospital setting or area. Thus there is little that we can compare our results on this font. Equally, none have compared a psychiatric ward to a surgical ward. One of the predictors for a higher number of prescribing errors as noted by Tully and Buchan (2009) is the number of patients who had their charts clinically reviewed. Thus, since the medical ward had the most number of patients admitted and the most number of patient records that were scrutinized, this helps explain why the medical ward had the highest number of errors when compared to the other two wards.

When comparing the different error scenarios across each ward, the most frequently occurring error in the medical ward were unsigned prescriptions (35%) while the most frequently occurring error in the surgical ward was ambiguously written prescriptions (23%). Unsigned prescriptions in the surgical ward only accounted for 9% of all errors. Comparatively ambiguous prescriptions accounted for 15% of all errors in the medical ward and were the second most frequently occurring type of error in that ward. Similar to the surgical ward, ambiguous prescriptions accounted for approximately 35% of all errors in the psychiatric ward which was the most frequently occurring error in this ward. This seems to be a trend in other studies of psychiatric wards and was due to the number of PRN (when necessary) medications that are prescribed. Only 1% of all errors in the psychiatric ward were accounted for by unsigned prescriptions, which are much lower than our medical or surgical wards and could indicate great accountability in the psychiatric ward or a ward culture where nurses re-transcribe medicines less.

The number of ambiguous prescriptions in the medical ward was lower than the psychiatric ward and the surgical ward. This, however, must be interpreted with caution as the sample size of prescriptions from the medical ward was larger when compared to the other two wards. The prescription of one tablet of a drug that is available in more than one strength, was higher in occurrence in the surgical ward as opposed to the medical ward. The larger number of errors was related to analgesics in the surgical ward and the prescribers unaware of the different dosage forms of certain chronic medications like simvastatin for example. This could indicate unfamiliarity of prescribers in the surgical wards with medicines used in the management of chronic conditions. Prescribing an incorrect dosage regimen was lower in the medical ward than the surgical ward, however, this must again be interpreted with

caution as the number of prescriptions and errors were fewer in the surgical ward when compared to the medical ward. Underdosing of medicine was similar in both the medical and the surgical ward accounting for 3% of all errors in each of the wards but was higher in the psychiatric ward accounting for 7% of all errors. The use of drug name abbreviations or non-standard nomenclature which accounted for 5% of all errors in the medical ward, was similar in the surgical ward (even though the number of prescriptions was smaller) but higher in the psychiatric ward where it accounted for 8% of all errors. Across all three wards, the occurrences of illegible prescriptions were similar and accounted for 6-7% of all errors. Omission of the routes of administrations were similar across all three ward with the lowest being 6% in the medical ward and the surgical and psychiatric wards being the same at 8%. The medical and surgical wards were the only wards that had the error of prescribing a drug for longer than was necessary and this account for 1% of all errors in the medical ward and 3% in the surgical ward. Prescribing a clinically contraindicated drug for a patient were similar in occurrence in the medical and the psychiatric ward and was not noted in the surgical ward. Prescribing inapt doses for the patient's renal function occurred only in the medical ward and did not occur in the other two wards. The prescription of dose above the maximum dose in the SAMF which occurred only 1% of the time in the medical ward, accounted for 13% of all errors in the psychiatric ward and did not occur in the surgical ward. While misspelling of a drug name only accounted for 1% of all occurrences of error scenarios in the medical ward, it accounted for 4% of all errors in the psychiatric ward.

5.9 Paediatric Ward

In paediatrics, dose calculations are required as almost all the drugs prescribed would have dose variations based on age (Davis, 2011). Furthermore, there are sometimes multiple calculations required in paediatrics prior to the prescription of errors which can result in an increased chance of a prescriber making an error (Otero *et al.,* 2008). Thus we expected dosing errors to be the most frequently occurring type of error in our sample. Therefore, it was not surprise when the most frequently occurring error noted in our paediatric ward was dose related and accounted for 37% of all errors. This is in line with other studies into paediatric prescribing errors such as Horri *et al.,* (2014), Khalili *et al.,* (2011), and Kidd *et al.,* (2010). However, in contrast to this, dosing errors were only the third most frequent accounting 11.3% of errors in the study by Ghaleb *et al.,* (2010) and the third most frequently reported type of error that was reported by Gokhul *et al.,* (2016). One has to bear in mind, however, that some of the errors were reported by the staff on the ward by Gokhul *et al.,* (2016) and also demonstrated that staff have a problem with calculating doses and thus this error may have been underreported (Davis, 2011). Additionally in the pre-invention stage at a study by Davey *et al.,* (2008) the predominant error accounted for was lack of frequency information on PRN doses. While the 37% in our study was higher than reported by Ghaleb *et al.,* (2010), Davey *et al.,* (2008), our study was a retrospective study while the studies mentioned here were either intervention studies or prospective prescribing audits which are known to produce lower rates of prescribing errors detected. The percentage reported in our study was not as high as the 72% that was suggested by Khallili *et al.,* (2011) but this study was in a paediatric surgical ward whereas our study took place in a general paediatric ward. Incorrect dosing accounted for 10% of all prescribing

errors that were reported by Otero *et al.,* (2008), making the 37% in this sample, higher than the amount reported by Otero *et al.,* (2008).

The second most frequently occurring error of ambiguous medication orders in our study was not reported by Ghaleb *et al.,* (2010). It is unclear if this type of an error fell into the miscellaneous category reported by Ghaleb et al., (2010). This was also not reported by Otero *et al.,* (2008) or Davey *et al.,* (2008) nor was it reported by Gokhul *et al.,* (2016). It is likely that in all these studies, either the pharmacist who collected these prescriptions were well aware of the way prescribers wrote prescriptions and thus would not probably consider the prescriptions written to be ambiguous.

Incorrect dosage regimen accounted for 6% of all errors in our paediatric ward. This was similar to the percentage reported by Ghaleb *et al.,* (2010) who reported this type of error at 6.6%. It was lower than the 22% reported by Otero *et al.,* (2008). It was not noted as an error by Davey *et al.,* (2008), partially because of the difference in the error scenarios that were used by Davey *et al.,* (2008) and thus direct comparison with regards to this type of error was not possible.

Not signing the prescription was not noted by Ghaleb *et al.,* (2010), by itself, it was considered as part of a bigger category called incomplete prescription which accounted for 41.2% of all errors. This implies that an accurate percentage of unsigned prescription was not determined and thus direct comparison of our number is not possible. Unsigned prescriptions accounted for 6% of all errors in our paediatric ward was higher than the 2.8% reported by Davey *et al.,* (2008). It is, however, important to note that this number described by Davey *et al.,* (2008) included prescriptions without both dates and signatures. The number of unsigned prescriptions was not reported by Gokhul *et al.,* (2016) did not

note any unsigned prescriptions most probably because there were no written prescriptions in this study all medicines were prescribed via a computerized prescribing system.

Both prescribing without adjusting for body size, and prescribing without adjusting for age were not noted as an error by Ghaleb *et al.,* (2010). These errors were also not noted by Otero *et al*., (2008) or Davey *et al.,* (2008). Similarly, internationally in the UK, the error of prescribing without documenting a child's weight, which accounted for 6% of errors in our study was not noted by Ghaleb *et al.,* (2010); Davey *et al.,* (2008) or Otero *et al.,* (2008). It was also not noted in the study by Gokhul *et al.,* (2016). It is possible this may have been part of the category that Ghaleb *et al.,* (2010) called the omission category.

Prescribing PRN drugs without noting the maximum dose which accounted for 5% of all errors in this ward. This is lower than the 7.2% reported by Davey *et al.,* (2008). This may be due to the fact that the ward under study by Davey *et al.,* (2008) had both orthopaedic and surgical patients and are thus prescribing a number of analgesics which are often prescribed as PRN dosages. It is unclear if this would be covered under the omissions category by both Ghaleb *et al.,* (2010) and Otero *et al.,* (2008).

Illegible prescriptions accounted for 4% of all errors in this sample were lower than the 9% reported by Otero *et al.,* (2008). This was not reported as an error scenario by Davey *et al.,* (2008). The 4% was very similar to the 3.6% reported by Ghaleb *et al.,* (2010). Underdosing of medicines could be considered a dosing error but this was not differentiated in the study by Ghaleb *et al.,* (2010) or Otero *et al.,* (2008).

The percentage of under dosed medicines (3%) in this sample was higher than the percentage reported by Davey *et al.,* (2008). Misspelling of a drug name which accounted

for 2% in this sample is lower than the 8.4% of miscellaneous errors reported by Ghaleb *et al.,* (2010). It is important to note, however, that this category not only covers misspelling of drug names but also drug interactions and other unspecified errors. No such errors were reported by Davey *et al.,* (2008) or Otero *et al.,* (2008). The use of drug name abbreviations or non-standard nomenclature which accounted for only 1% in this sample was much lower than the 24% reported by Ghaleb *et al.* (2010). Possibly, this could be due to the number of paediatric wards included in the study by Ghaleb *et al*., (2010). No reports of this type of error by Davey *et al.,* (2008) and Otero *et al.,* (2008).It is worth noting that in this error was the least frequent in the sample examined in this study but the second most frequently reported in the study by Ghaleb *et al.,* (2010).

5.10 Comparing the Medical ward to the Surgical, Psychiatric and Paediatric ward

As stated in the previous chapter, multinomial logistic regression was used to compare the total errors of each ward to each other and to note whether or not there were any statistically significant differences. It is important to remember that the based outcome was zero errors and the base used was the medical ward.

5.10.1 One error

There was a statistically significant difference between the medical and the surgical ward in terms of one error with a p value <0.05. When comparing the medical ward and psychiatric ward, there is also a statistically significant difference between these two wards as the p value was less than 0.001. When comparing the paediatric to the medical ward and factoring prescriptions with a total of one error, there was a statistically significant

difference between these was p <0.05. Thus, for one error on a prescription there seems to be a statistically significant difference between the medical wards and all the other wards that were assessed in our study. This is in line with the findings of the study by Franklin et al., (2011) who found that there was a statistically significant difference between errors in the medical wards that the group investigated and the surgical wards. A similar finding is mirrored in the results presented by Ryan et al., (2014) who also noted a statistically significant difference between the medical and surgical wards. Thus our findings support the findings made by Franklin et al., (2011) and Ryan et al., (2014) but only for a prescription that has one error on it. There are no studies that we are aware of which compared medical wards to psychiatric wards or medical wards to paediatric wards either within the same institutions or across multiple institutions.

5.10.2 Two errors

When comparing the medical ward to the surgical and factoring the number of prescriptions with a total of two errors, there was no statistically significant difference between ($p>0.05$). There was, however, a statistically significant difference between the medical ward and the psychiatric ward with $p<0.05$. There was also a statistically significant difference between the medical ward and paediatric ward with $p<0.01$. Thus, when examining prescriptions with two in our study, there was no longer a statistically significant difference between the medical ward and the surgical ward. Since studies by Franklin *et al.,* (2011) and Ryan *et al.,* (2014) do not stratify their p-values in relation to the number of errors on a prescriptions we cannot compare these results (for two or more errors) from our study to their.

5.10.3 Three Errors

When examining specifically at prescriptions with a total of 3 errors on them and comparing the medical ward to the surgical ward, there was no statistically significant difference between these wards with $p>0.05$. When comparing the medical ward and psychiatric ward there was a statistically significant difference between these wards with $p<0.01$ and. When comparing the medical ward to the paediatric ward there was a statistically significant difference between these two wards ($p<0.01$). These values must, however, be interpreted with caution because of the relatively small number of prescriptions that contained three or more errors.

5.10.4 Three or more errors

It is important to understand that when interpreting the data for both prescriptions with a total of three errors or four errors that this sample size is too small and thus any particular conclusions that can be drawn from this should be approached with caution. As a result, only with a larger number of these two scenarios could anything concrete be said with regards to their actual significance.

5.10.5 Final Thoughts on this Analysis

Just like other studies we showed that there was a statistically significant difference between the numbers of errors and different wards investigated in our study. However, different from other studies this was dependent on the number of errors that were on the prescription. Particularly when we examine prescriptions with three or more errors, since these only occurred in small numbers and only in the psychiatric and paediatric wards, we cannot draw any inferences from this data.

5.11 Relative Risk Ratio

The relative risk ratio was used to compare the relative risk of the having a prescription with an error on it when comparing the medical ward to the other three wards in the sample obtained from the hospital under study. Each of these has been separated are out into the number of prescriptions with one, two, three or four as the total number of errors.

5.11.1 Relative Risk of One Error

When examining the relative risk ratio with the medical ward as a base of 1 and base outcome of no errors, the relative risk ratio between the medical and surgical ward of 0.59 indicated that the risk of having a prescription with one error is less likely in the surgical ward when compared to the medical ward with $p<0.05$ and a 95% CI (0.38-0.90) that did not pass 1 indicating that there was a difference between these wards. Thus, in our study the relative risk of having a prescription with one error was less likely in the in the surgical ward than the medical ward. Ryan and colleagues (2014) noted that within designated teaching hospitals (such as ours) errors were more likely in the surgical ward or mixed wards than the medical wards. Our findings show that when examining one error, the risk of a prescribing error was more likely in the medical ward than the surgical ward. However, Ryan *et al.,* (2014) did not do relative risk ratios so we cannot compare our results directly to theirs.

Furthermore, on examination of the relative risk ratio comparing the medical ward to the psychiatric ward, the ratio of 0.42 with $p<0.0001$ and a 95% CI (0.28-0.64) that did not pass 1 indicates, the relative risk of having a prescription with a one error was less likely to happen in the medical ward than the psychiatric ward. To our knowledge, there have been no studies that have examined prescribing errors in psychiatric wards and their likelihood to

have errors over medical wards. Thus, our findings suggest that the relative risk of having a prescription with one error was less likely in the psychiatric ward than the medical ward.

The relative risk ratio of 1.46 with $p<0.05$ and a 95% confidence interval (1.09-1.96), that indicated a difference between the medical and paediatric ward, informs us that the relative risk of having a prescription with a total of one error is more likely in the paediatric ward when compared to the medical ward. Miller *et al.,* (2007) noted that there was an increased risk for medication errors in paediatrics when compared to adults. Since we compared a general medical ward to a general paediatric ward within the same hospital and our relative risk ratio should an increased risk, we can say that our study supports the assertion made by Miller *et al.,* (2007).

5.11.2 Relative Risk of Two Errors

When examining prescriptions with a total of two errors, and comparing the medical ward to the surgical ward, there relative risk ratio would suggest a higher risk of having a prescription two errors in the medical ward than the surgical ward. However, even though there is statistical significance ($p=0.737$), the 95% CI (0.21-2.97) does pass one and indicates that there is no actual difference between these two arms of the study. Again here our findings differ from that of Ryan *et al.,* (2014). We found there is no meaningful increase in risk between the medical and surgical wards and thus the risk of a patient having two errors on a prescription is the same in both our medical and surgical wards.

The relative risk ratio of 2.81 when comparing the medical ward to psychiatric ward with $p<0.05$ and 95% CI (1.22-6.42) which indicated a difference between the medical ward and

the psychiatric ward, informed us the relative risk of having a prescription with 2 errors is more likely in the psychiatric ward than the medical ward.

Similarly, such a relationship exists between the medical ward and the paediatric ward. The relative risk ratio of 3.02 with $p<0.01$ and a 95% CI (1.32-6.92) which indicated a difference between the medical ward and paediatric ward, informed us that the relative risk of having a prescription with a total of two errors is more likely in the paediatric ward than the medical ward. Again here we are able to prove the assertion made by Miller *et al.,* (2007) of an increased risk of prescribing errors in paediatric patients.

5.11.3 Relative Risk of Three Errors

An examination of prescriptions with a total of three errors, the relative risk ratio of 0.92 when comparing the medical ward to the surgical ward would normally indicate that the risk of having a prescription with one error was less in the surgical ward, however, the p value was not statistically significant ($p=0.287$) and the 95% CI (0.78-1.07) crossed one. Thus the risk of having prescriptions with three errors is the same in both the medical and surgical wards.

When comparing the medical ward to the psychiatric and the medical ward to the paediatric ward, the relative ratios in both these cases is far too large to be of any importance as the sample of three errors is very small and as result no meaningful conclusions can be drawn from them. Thus these results must be interpreted with caution and may actually not be meaningful unless confirmed with a much larger sample.

5.11.4 Relative Risk of Four errors

An examination of prescriptions with a total of four errors, the relative risk ratio of 0.92 when comparing the medical ward to the surgical ward would normally indicate that the risk of having a prescription with one error was less in the surgical ward, however, this was not statistically significant (p=0.265) and the 95% CI crossed one. When comparing the medical ward to the psychiatric, the relative ratio is far too large to be of any importance as the sample of four errors is very small and as result no meaningful conclusions can be drawn from them. It should be noted that only the psychiatric ward that has one prescription with four errors and this did not occur in any other ward. Furthermore, the comparison of the medical ward to the psychiatric ward, the relative risk ratio of 1.08 would normally indicate that the relative risk of a prescription with four errors would be more likely in the paediatric ward, however, this was not statistically significant (p>0.05) and 95% CI crosses one. Hence there is no difference between these two arms.

5.11.5 Final Thoughts on the Relative Risk Ratios

Errors were more likely in the paediatric ward than the medical ward suggesting that errors are more likely paediatric than the adult population. For two errors on a prescription, there was no difference in the relative risk of having a prescription with an error between the medical and surgical. However, for two errors, errors are more likely in the psychiatric ward than the medical ward. This corroborates some of Ryan *et al.,* (2014) findings as a ward other than the medical ward has the highest risk of error. There was good correlation between the multinomial logistic regression analysis and the relative risk ratios that we determined in this study.

CHAPTER 6: SYSTEMATIC FACTORS IN MEDICATION ERRORS

Introduction

To ascertain the systematic causes of medication errors qualitative methods have been utilized by a number of authors from different parts of the world (Dean *et al.,* 2002a; Coombes *et al.,* 2008; Dornan *et al.,* 2009; Duncan *et al.,* 2012; Ross *et al.,* 2013; Ajemigbetse *et al.,* 2013; Lewis *et al.,* 2014; Keers *et al.,* 2015). In most of these studies listed above thematic content analysis was used to analyse the data following the data collection process.

In this chapter, the findings of the focus groups will be presented and then discussed in an integrated manner. The focus groups had participants from different areas of the hospital allowing the researchers some insight into the functioning of the hospital. The themes that were decided on included: hospital process, ward environment, types of errors, team function and teaching and learning. The categories under each theme came from the each of the groups of the professionals concerned. There were some crossovers between categories. Table 15 illustrates the relationships between codes, categories and themes that were derived from the focus group discussions.

Table 15: Relationship of codes, categories and themes derived from focus group discussions

Themes	Category	Code
Hospital Process	Patient Care	Repeat mistake makers
		Nurses caught between doctor's opinions
		Incomplete referrals
		Charting
Ward Environment	Ward Culture	Lack of Accountability
	Work Conditions	Lack of Staff
		Long Shifts
		Out of Scope Work
Types of Errors	Written Records Issues	Illegibility of prescriptions
		Incomplete prescriptions
		Dose related errors
		Transcription Related errors
Inter-professional practice	Team Function	Communication between professionals
		Ward Pharmacist
Teaching and Learning	Knowledge Gaps	Emphasis on clinical knowledge over pharmacology knowledge.
		Lack of trade name knowledge.
		Lack of knowledge by new doctors
	Didactic Instruction	Lack of Clinical Pharmacology training
		Role Play in teaching
		Writing of prescriptions
		Need for an app

6.1 Hospital Process

The category that came up under the theme of Hospital process was that of patient care and aspects that related to patient care.

6.1.1 Patient Care

The codes under patient care that came up in the focus groups included aspects of repeated mistake making, nurses not knowing which doctor to listen to, doctors getting incomplete patient referrals and even issues related to charting.

6.1.1.1 Repeat Mistake Makers

During the focus group it became apparent that the same doctors continued to make errors on prescriptions. This was especially apparent for patients who were sent up to the wards from casualty. There was a clear feeling that casualty doctors do not fill in the charts of patients correctly and thus the nurses were then required to phone down to casualty to get hold of the doctor to rectify the mistake to prevent potential harm to the patient.

> *"Yes we phone down to casualty because it is the same doctors. We phone the doctor to tell us that this is the kind of medication that is written up, I don't understand it, then he can tell you how often do you give it"* **FG1N3**

The question as to why the same doctors repeat the same mistakes has to be addressed. International literature suggests that often doctors do not get feedback regarding their prescribing errors and thus as a result, they continue to make the same errors over and over again (Franklin *et al.,* 2011; Dean *et al.,* 2002a; Dornan *et al.*, 2009; Reynolds *et al.,* 2016). Feedback as noted by Reynolds *et al.,* (2016) enables improvements and changes in

behaviour. Within the situation described by the nurse above, the doctors do not receive actual feedback regarding the errors committed. Instead their assumption is that the nurse just does not understand what they are prescribing. Thus to improve the system, there needs to be clear plans for feedback. Often the nurses are the ones who spot the errors, and as it will be shown later have problems in their communication with the doctors. Thus feedback should become a part of the system to ensure that these kinds of errors are minimized. Feedback must however be timely, useful, credible and relevant (Reynolds *et al.,* 2016; Hysong *et al.,* 2006; Jamvedt *et al.,* 2006; De Vos *et al.,* 2009; Van der Veer *et al.,* 2010). As Reynolds *et al.,* (2016) notes there are very few intervention studies that have looked specifically at providing prescriber feedback. Franklin *et al.,* (2007) noted that pharmacists should be the ones to provide feedback to prescribers on a one on one basis. However, as Reynolds *et al.,* (2016) points out this is not always possible given the way hospitals are structured. It is worth noting however that Reynolds *et al.,* (2016) as well as Ivers *et al.,* (2012) note that prescriber feedback only produces a small to moderate effect on professional practice and thus intervention cannot be introduced in isolation.

6.1.1.2 Nurses Caught Between Doctor's Opinions

On the wards, one patient is sometimes treated by two doctors from differing specialties. When these doctors issue conflicting prescribing instructions the nurses find it difficult since they are taken to task for either complying or not with the differing instructions. These doctors do not seem to be talking to one another about their care of the same patient. Consequently, the nurse maybe be instructed by one doctor to stop a patient's medicine and then the next doctor will want to know exactly why the medication was stopped. This problem seems to be exacerbated by the large number of junior nurses in the hospital who

are often caught in between these different specialty doctor's orders. This creates confusion for the junior nurses with respect to hierarchy of physicians within the unit and the protocols for medicines management.

> *"Uhm, I think we having problem with communication amongst doctors and also it affects the nursing staff because they must carry the orders. We having a team intensivists, the surgeons, there is no communication amongst those people…their manager is always in between to ensure that whether they like it or not, they need to communicate but still it doesn't help because the other one will say to the junior nurse, give this medication, and the other team will say why did you give this medication because I'm in charge of this patient."* **FG3N8**

The consequence of these actions seems to be a delay in the therapy of patients. This is clear from the focus groups that if the nurses are unsure of what to do, i.e. to stop or to continue the medicine of the patient, they withhold the treatment of the patient until they can actually consult with a senior doctor and a decision by the senior prescriber can be made. This is potentially valuable time in the treatment of the patient that can be lost. This is a clear system problem that in the end could lead to potential patient harm. The quote below illustrates what happens when the nurses are unsure of what to do:

> *"This thing of finding charts, the doctor has written Augmentin, it stopped on the first page but where you have to chart that its given or not, must you still continue with it but the other side is stopped. So you don't know whether to give or not to give because the other side is written stop, but that side are you giving it or not? It happened with me last week. yes, the sister said I must wait. Yes, then you can't do anything, you have to just wait until he comes out."* **FG1N4**

This problem of finding incomplete written medical notes and drug information regarding whether or not patients should continue or be stopped on medicines has been reported by other authors as well (Franklin *et al.,* 2011; Dean *et al.,* 2002a; Ross *et al.,* 2013; Dornan *et al.,* 2009; Dearden *et al.,* 2015). All these authors noted that such situations are error provoking conditions and lead to errors by prescribers.

Improving communication between the members of the ward team would be ideal in this situation. There needs to be clear communication between the doctors and the nurses and when multiple doctors are involved they need to ensure that they make clear, unambiguous notes of the medication related changes that they want to make. The head nurses should also be made aware of the changes to the patient's regimen so that they can then instruct the more junior nurses, as often the more junior nurses go to their seniors for advice on what to do regarding the ambiguous or contrasting medicines related information. This way there should be no delay in the patient receiving therapy. International literature has suggested that a lack of communication can result in errors as a result of lack of communication between members of the healthcare team (Ross *et al.,* 2013; Page *et al.,* 2008; Coombes *et al.,* 2008; Tully *et al.,* 2009; Patterson *et al.,* 2004).

Thus in addition to the therapy being delayed in some patients there is also the possibility of a prescribing error taking place due to the lack of communication between different teams seeing the same patient. Lewis et al., (2014) noted that one of the methods to reduce this type of error is through the introduction of a standardized tool to improve communication between doctors inter-professionally as well as intra-professionally.

Another issue affecting patient care concerned charting processes and the lack of charting by both their doctors and nurses on their wards.

6.1.1.3 Incomplete Referrals

The doctors pointed out that there was generally information lacking in the patient referral letters when patients were referred to their wards. Most often they found that the information that was lacking was not the clinical information but the information regarding the medicines that the patient was taking. This, they explained, gave them an "incomplete picture" of the patient. They also commented that if they got some notes with regards to medicines, that information was incomplete and lacked details such as what dose of the drug the patient was being treated with. This seemed to be a problem especially when patients were referred from other hospitals.

> *"There are definitely gaps in prescribing and the information that you get at every level whether it's a referral letter from another doctor in another hospital because I often find that the meds are never written. They'll give you a clinical picture of the patient but they will never tell you 'this is the antibiotic the child was on and for how long' you know these are the meds, you'll get a nice clinical picture but you'll never get the meds or the doses so in terms of referral that's definitely something that's lacking."* **FG2D2**

The complaints of these doctors in the hospital regarding referrals is similar to the findings of Ross and her colleagues (2013) in their study of the causes of prescribing errors by junior doctors in hospital inpatients. The participants in this study complained that often previous doctor's completed tasks such as medicines reconciliation and documentation poorly and this then resulted in errors. This was reported both on patient admissions and also afterward rounds. The problem of incomplete or inadequate medicines information and poor charting (whether at admission or at other times) is a theme reported by other studies

as well (Ryan *et al.*,2014; Dornan *et al.*, 2009; Dearden *et al.,* 2015). Participants in these studies noted that a lack of medicine and charting information led to them committing errors.

6.1.1.4 Charting

In light of these charting difficulties, the doctors suggested that a redesign of the current medication charting system was required. They would prefer to have the chart to take into account the variety of information required for both the administration of the medicine and also have space so that no information would be incomplete. This would also allow for less ambiguity regarding the dosing of medication for children.

> *"I think the real medication chart should have place for the generic prescription as well as the trade name if you want the trade name such as number 9 says its wrong for people to be prescribing on trade names. Number 11 says that there should be a place there for a mg dose as well as a ml dose and you shouldn't be prescribing ml. There should be a space for each drug and what the kg of the child is and the dose that you actually prescribed. I think that the chart should have a limit of 4-5 days before it needs to be re-written. Number 5, I feel like there aren't really charts for the nurses to print their name so you don't actually know who has dispensed the drug. I think that those are my main issues with the chart"* **FG2D1**

It was noted in the field journal as well, the prescribing charts only have a very small space where a large proportion of the prescribing information must be transcribed to. More space is allowed on the side of the prescribing sheet for nurses to chart when the drugs have been administered. It also then means that the drug can be continuously given to the patient

even if the patient no longer needs it, as it is written open ended, unless a specific doctor tries to fill in the space available the duration of the patient's therapy.

Whilst all the space is provided for the nurses to actually chart information both on the medication form and elsewhere in the patient files, the doctors themselves agreed that this did not always happen and consequently the doctors attending to such a patient were left wondering as to whether the medicine had been given to the patient or not. This may be linked to what the nurse's focus groups told the research team with regards to not knowing which of the different doctor's instructions to follow and thus not actually doing anything and delaying the patient's therapy as a result. As is clear from the quote below, there is often a case where it is not noted whether the drug has been administered to the patient or not.

> *"In terms of the sisters, their documentation as well, sometimes we have to go to them and the drug may have been prescribed but not signed or dispensed and not signed for so that kind of information is not meticulously given to us, or if the medication is out of stock, sometimes there are codes that we don't understand that are written there or sometimes they're just blank"* **FG2D8**

In terms of the lack of documentation by other members of the team like nurses, this is a problem which was brought up in other studies (Ryan *et al.*, 2013). This lack of information including poorly written medical notes when patients are transferred as well as whether or not the patient is continuing to take a particular medicine or whether medicine has been stopped has also been reported by Franklin and her colleagues (2011). Other studies have also noted these as errors provoking conditions (Tully *et al.,* 2009; Coombes *et al.,* 2008; Kopp *et al.,* 2006; Lederman and Parkes*,* 2005; Patterson *et al.,* 2004 Dean *et al.,* 2002a;

Leape *et al.,* 1995). These studies took place in developed nations, Ajemigbetse *et al.,* (2013) noted a similar situation regarding inadequate documentation leading to prescribing errors in Nigeria. When taking that information into account the importance of proper charting is paramount in the prevention of medicine related errors. Thus the charting by the nurses and the medical practitioners involved should be improved to reduce the risk of errors.

The other problem with regards to the charting seemed to be the issue of the difference in the charting system between the casualty and the wards. This seemed to make the work of nurses more difficult since they are then forced to transcribe the information onto their own charting system in the ward, so that if they are audited everything looks in order. The priority among the nursing staff is to ensure a clean audit and not prescription completeness.

> *"The other thing is that because we using different prescription chart, from the casualty, at the ward, we don't use that one and then maybe from the casualty that one is not legible and then you need the chart to be neat and then when you go to auditing we need our stuff to be presentable that's why we have to transcribe to make it the way we want it to be."* **FG1N3**

These data are congruent with data presented by other research teams like Coombes *et al.,* (2008). In their study in Australia, the group of interns who made prescribing errors also complained about the type of charts that were being used. Coombes *et al.,* (2008) also worked off hand written prescriptions and the charts lead to eight re-prescribing errors and one new prescribing error out of a total of nineteen related errors that Coombes and his colleagues (2008) could identify. The data is also congruent with information that junior doctors provided to Dornan *et al.,* (2009), who noted in their study that the design of drug

charts made it sometimes more difficult to prescribe medicine because not enough space is provided for important patient details.

The problem of using different charts in different parts of the hospital augments the argument by the doctors that there needs to be a redesign of the medicines charting system. The hospital should institute a universal charting system that has space for a thorough medication history form on it. The obvious argument is that this may still not be filled in correctly, or for that matter even legibly as the quote above alludes to, but such a system could potentially save time for the all the health professionals involved in the process. Dean and her colleagues (2002a) have suggested the idea that drug chart should include information with regards to the rationale for prescribing the medicine for patient concerned, the patient's allergy profile and that strict prescribing policies should be adhered to.

Thus a useful intervention could be a universal prescribing policy and drug chart. Coombes *et al.,* (2008) had similar findings regarding the problems with charting, and in their following intervention study they redesigned prescriptions charts used in the hospital (Coombes *et al.,* 2009). Their study found that by redesigning the prescriptions charts according to the feedback that was received in their previous study; they produced a statistically significant 5% reduction in prescribing error. This trial was so successful that after small modifications the redesigned charts were used throughout the hospital and then further rolled out nationwide. This study serves as proof that a charting system, if redesigned according to the prescriber's needs and the types of errors investigated, significantly reduces the amount of prescribing errors.

6.2 Ward Environment

The theme of ward environment was raised in all focus group. In general, the work conditions on their respective wards were discussed along with both the lack of material resources and the ward culture. These are explained in detail below.

6.2.1 Ward Culture

There was a difference of opinion between the nurses and the doctors with regards to ward culture especially relating to the question of a culture of blame. One of the nurses, in the focus group was clear that she thought there was a culture of blame on her ward.

> *"uhm, I think a lot of people will make a mistake and not say a word to anyone. And I think that I've made a mistake recently, and I told about it but I didn't get the most enduring response."* **FG1N1**

It is clear from her responses that making a mistake is a problem on her ward and that if you admit to making a mistake people do not treat you well. Although the word "enduring" in anomalous and open to interpretation, it was clear from the context that she meant that she was being judged and blamed for her mistake.

This is in contrast to what the doctors told us when the subject of blame was broached with them. One of the doctors seemed to suggest a very open relationship between themselves and other doctors; one of dialog and discussion and not immediate blame.

> *"[I] Call the person that wrote the prescription and discuss it with them just to see why, because sometimes there are reasons so that you don't just change or stop something that might be very important."***FG2D6**

One of the positive aspects that the doctors reported was that interns could easily turn to their more senior colleagues in the event that they noticed an error on a prescription. They could take their problem with the prescription to a senior doctor (either a medical officer or a registrar) and the more senior doctor would then go on and speak to the person who had written the prescription.

> *"in that case, you'll just go to the senior and say I think that this is wrong and try to take it up with that person the next day or find out what happened."* **FG2D14**

Currently the hierarchy of the hospital ward staff includes: the senior consultant, consultants, registrars in that specialty, the medical officers (MO's), the interns and the nurses. The interns report to the medical officers and registrars. The medical officers report to the registrars and consultants. The registrars report to the consultants and the senior or head consultant on the ward.

Using the hierarchical structure for reporting a prescribing error would reduce the intimidation a younger or newly qualified doctor would feel having to confront a senior work colleague in the hospital. It also increases the chances of the person who had made the error listening to the problem and being cognizant of it in future instead of being dismissive of it. The intimidation felt by interns when dealing with doctors who are higher up than them such as consultants and registrars, has been shown to be factor in causing prescribing errors by Coombes *et al.,* (2008), Franklin *et al*., (2011), Dean *et al.,*(2002a), Dornan et al., (2009), Duncan et al., (2012); Lewis et al., (2014) and Ajemigbestse et al., (2013). The junior doctors (interns) in these studies pointed to the fact that they were often told what to do and were forced to do it. It was considered a "collective decision" but they

were the ones who were left with responsibility to carry it out. Thus they had nobody to turn to or even to consult with if they felt the instructions contained errors.

Whilst it is optimal to have good open communication between more junior staff and senior staff where errors are concerned, Coombes and his colleagues (2008) found that often younger staff members did not know when to turn to their older colleagues for help. Lewis *et al.,* (2014) also noted that sometimes young doctors get caught up in the behaviour of wanting to emulate their experienced colleagues and thus some of them start to believe that they are now doctors and should know what was going on, making them less likely to turn to others for help. Thus even with optimal communication there is still a possibility that this situation can result in an error.

6.2.1.1 Lack of Accountability

The doctors seemed to be more interested in other aspects of ward culture than their nursing counterparts. They demonstrated their aversion for staff on the ward that were not accountable for their actions. The doctors suggested that the night staff might be more of a problem when compared to the day staff when it comes to the issue of lack of accountability.

One doctor explained that when an error took place at night, the doctors would turn to the staff to find out what had happened and nobody would be able to explain the situation to them.

> *"Following on your comment (6), it's often a general lack of accountability. So when you question somebody during the day it's got nothing to do with the day staff it's the night staff and that is the problem at all levels."* **FG2D11**

Whilst the comment above suggests that there is a lack of accountability on the part of the night staff for the patients, it must be questioned whether the night staff members have enough time to get to know the patients properly. As pointed out in a study by Franklin *et al.,*(2011) often the night staff don't get to know the patients as well as the day staff because they often have to look after such a large number of patients and may even have to cover an entire area of the hospital during the night shift. This could explain the night shifts staff lack of accountability, because they sometimes they have to prescribe drugs to patients whose full history they do not know or fully understand (Franklin *et al.,* 2011). This was a problem also noted by Lewis *et al.,* (2014) who also noted that part of the reason for this capitulation on the part of the night staff was tiredness. They are then unlikely to want to simply take responsibility for their actions.

6.2.2. Work Conditions

6.2.2.1 Lack of Staff

There was agreement in both groups of professionals regarding the lack of doctors and nurses on the wards in the hospital.

The lack of staff on the wards resulted in a managerial decision to deploy inexperienced staff to work some shifts. One of the problems that the nurses had was the locum staff from nursing agencies as well as new staff were untrained in ward procedures and policies which also then placed added pressure on them which resulted in them not being able to do their job as effectively as possible. It is important to note that it is not just about simply having staff on the wards, there needs to be experienced staff members who actually understand the drug regimens for these patients.

"I agree with them, we are understaffed, in ICU we are supposed to be one is to one, but at some point because of the shortage, you find that even the agency doesn't have people to replace so we end up sharing patients." **FG3N5**

"*Yes, we are understaffed because in a critical area, you need to have qualified people trained in a speciality. But now we are merged to use staff nurses, whereby you need to focus more to them than to the patient because you need to see each and every step that they are taking, is it the right, are they doing the things correctly, but you find that you are given; yoh, a quarter of the ward is staff nurses. It is imposing a lot of pressure to the few trained people. Yes, others are trained, but they still have to gel the knowledge to the practice, because they have just qualified, so you need to mix in the two things so that you know that what I am doing is the right thing, so if you're going to be given a staff nurse to look after, having just qualified it is a bit difficult."* **FG3N4**

It is clear from the quote above that is not just simply a question of having staff but more a question of having staff with sufficient experience to be able to take on the work that is required of them. A similar sentiment also came up during the doctor's focus group, where they also wanted more experienced staff members. They rationale was also one of having somebody with experience to be able to supervise more junior members of staff especially in the areas of prescribing and medicines.

"If you specifically speaking about prescribing errors, I think our problems are at all three levels. There isn't enough consultant supervision of registrars. There aren't enough registrars to actually care for the patients or supervise the medical officers.

*And the amount of actual work that needs to be done is spread thinly among the medical officers. So it is at all three levels."***FG2D1**

Duncan *et al.,* (2012), Ryan *et al.,* (2014) and Duncan *et al.,* (2009) noted that low levels of staffing was a cause of prescribing errors in their respective studies. The other problem with a lack of staff is high workloads, which Lewis et al., (2014) notes increases the chances of a prescribing error. Prescribing errors are more likely when workloads are high.

These data also echoes what Coombes and colleagues (2008), Ryan et al., (2014), Nichols et al., (2008) and Dearden *et al.,* (2015) noted regarding the supervision of interns or newer members of staff. The authors noted that a lack of supervision of junior doctors were error producing conditions. Thus having a lack of senior staff or registrars could increase the risk of errors. In the study by Coombes *et al.,* (2008) one of the interns pointed to the fact that on the day that an error was committed by a particular intern the intern had to see 30 patients and their registrar was away to study for an exam, and a floating consultant was meant to supervise them who changed weekly. This may not seem like such a problem but in the study the interns pointed out that they often were given orders by consultants and then had to have these orders explained to them by the registrars (Coombes *et al.,* 2008). Still even with registrar's explaining to them what to do, they still had to be proactive and ask drug related questions if they required answers (Coombes et al., 2008). Franklin and her colleagues (2011) also found that some errors in prescribing could be blamed on incomplete supervision of more junior doctors.

Recently, the lack of supervision for junior staff was also noted in the media (Naidoo, 2017). The junior doctor interviewed for the article said that he sometimes worked without

supervision and could only phone his supervising consultant if it was a matter of life or death (Naidoo, 2007).

The sentiment of having somebody to supervise or mentor more junior doctors and nurses was also raised by the nurses. If a less experienced doctor comes into contact with a lesser experienced nurse or one not properly supervised, the danger is that the nurse might administer a medicine that the doctor has ordered without actually knowing the potential problems that it might cause.

> *"You know there a belief in nursing that doctors they understand medication, they know everything, nurses they believe that. Unless you are knowledgeable as a nurse then you'll be able to question and guide and mentor others. We heard one doctor somewhere, this doctor was looking for asking for Serenase IV and you know Serenase IV is very dangerous and this doctor was insisting that "we giving it, we giving it, we have been giving it", "where were you giving it?" then after, you know, that discussion, then the doctor understood when the sister said you can give Serenase but still that Serenase the patient needs to be monitored, you know, if it was not a nurse with knowledge, its lucky that that Serenase is not there, I don't know other units, if it was a nurse without knowledge, you know pharmacology not everybody remembers everything. It depends on the ICU sister or the experienced nurse, so I think somewhere they need, let's say in a unit if we can have mentorship, for the drugs that are used in that unit like especially key unit, maybe it will help, maybe in cardiac, Cordarone, maybe in general Cordarone, you know these common drugs that are very high risk, maybe that mentorship will help."* **FG3N8**

The above shares similarities with a study conducted by Keers and colleagues (2015) who noted that younger nurses were less likely to question the decision of a doctor and this thus resulted in a medication administration error. Furthermore, they noted that some younger nurses were of the opining that doctors did not make mistakes and thus would be less likely to question a decision of a prescriber even if they suspected there was a problem with the prescription.

The nurses also made mention of the fact that there is a clear need for some kind of orientation programme or even a mentorship programme that is required in the wards for the doctors. They alluded to the fact that often the doctors who had completed a particular rotation moved on and the new doctors who came in, had no idea how things worked on the respective wards in which they now found themselves.

> *"To add on that problem, during changeover of the doctors, all the doctors would just go especially the registrars and the medical officers, they won't just leave somebody behind who is going to teach the others, and then they don't even have an orientation programme so that is one other thing that is concerning medical errors, I think that if maybe there can be an orientation programme, they teach them an in-service programme also whereby they are going to teach them about the protocols because each and every ICU is having a protocol. So they are clueless and then when they are doing the rounds they are afraid to ask even the consultants, so they just check on their phones, they don't ask the bigger doctors "how is this supposed to be given". And then most of the medication in ICU is supposed to be titrated, for example potassium, they will just write potassium stat, give potassium 40mg and then for the ones who don't have experience it's going to be a problem because they*

will just take the potassium and push it in and then all of a sudden arrhythmias. Yeah so that is one of the problems." **FG3N5**

The above quote also brings into question whether having more senior staff would help if the new doctors still feel intimidated to speak to them and instead use applications on their phones to obtain information that they are ultimately unsure off. This can set a dangerous precedent as the quote above intimates especially in specialty areas like the ICU where medicines are given differently when compared to other wards in the hospital. This is similar to the findings by Franklin *et al.,* (2011) who pointed out that professional hierarchies often resulted in junior doctors not being able to speak to their seniors. It has been suggested that this could be caused by a lack of confidence or even a fear of exhibiting their lack of knowledge (Franklin *et al.*, 2011; Lewis et al., 2014).

Such a situation could result in, as the nurse has indicated above, the junior doctors not prescribing the medicine correctly or perhaps not even questioning how the medicine should be prescribed. This quote also brings into questions whether or not more senior staff would actually help the problem or may make the problem worse. It has been suggested by a number of authors that interns have difficulty speaking up to senior staff (such as consultants) even when they think a particular decision is wrong or dangerous (Dean *et al.,* 2002a; Coombes *et al.,* 2008; Nichols *et al.,* 2008; Dornan *et al.,* 2009; Lewis *et al.,* 2009; Franklin *et al.,* 2011; Duncan *et al.,* 2012).

In summing up the problem, whilst the nurses note a lack of supervision of prescribers is clearly a problem in the hospital there can be an argument made both for and against the need for extra supervision. It is important to point out, however, that often younger doctors do want supervision and that in the doctor's focus group they claimed that it was easy to

talk to anybody about prescribing decisions. Therefore, one can suggest a middle ground solution. Perhaps having an increase in the number of supervising doctors and clinicians, but in turn hiring people that are easily approachable and who are good at communicating effectively with younger doctors without making them feel intimidated.

6.2.2.2 Long Shifts

All the focus groups acknowledged the problem of long shifts. Whilst the consultants have traditional shifts of 8 hours, the medical officers, registrars and interns have very long shifts ranging between 24 to even 28 hours. The nurses on the other hand when doing night shift do 12 hours a day, 7 days a week.

> *"Registrars can be on the ground for at least, probably up to 27 -28 hours. From 8 o clock to 8 o clock plus four hours; so 24 plus 4 hours, so 28, 29 hours on a good day"* **FG2D1**

> *"Unless you are doing nights. If you're doing night duty then it's a straight shift. It's Monday until Monday."* **FG1N4**

The problem of working long shifts was also brought up by Coombes *et al.,* (2008); Dean *et al.,*(2002a); Lederman and Parkes(2005) and Naidoo (2017). These authors demonstrated that an increase in workload and long shifts results in more prescribing errors being committed by those interns who were on a longer shift.

The data on long shifts must be looked at in totality to get a better picture of the situation. The long shifts when combined with the lack of trained clinical supervisors and the lack of staff on the wards could create a scenario in which the combinations of these could potentially lead to the committing of prescribing errors (Coombes *et al,* 2008; Franklin *et al.,*

2011; Dean *et al.*, 2002a; Ajemigbetse *et al.,* 2013; Lewis *et al.,* 2014). The question therefore becomes what if all of them happen at once as in the case in the hospital under study. A potential situation may arise late one night where there is skeleton staff in which a less experienced doctor is required to make a prescribing decision regarding a patient with no senior doctor to turn to. This could result in a potentially deleterious error taking place. Given the qualitative results of the studies by Franklin *et al.,* (2011), Coombes *et al.,* (2008), Dornan *et al.,* (2009) and Ross *et al.,* (2013) it is clear that when any combination of these situations took place (either a lack of supervision, a high workload, a long shift, usually two of the three combined) the doctors under study were more likely commit some kind of error. Whilst there were no serious errors that could be found during the quantitative phase of this study, Reason's (2000) cheese model suggests that this is a possibility. The fact that the registrars or medical officers are at work for such a long time could lead them to make errors towards the end of their shift as they simply just want to go home. This need to get home quickly has been reported by Dean *et al.* (2002a). Such conditions also lead to fatigue and tiredness which are considered causative for errors (Ryan *et al.,* 2014; Dornan *et al.,* 2009; Lewis *et al.,* 2014).

6.2.2.3 Out of Scope Work

Another major category that emerged from both the focus groups is the amount of out of scope work the professional personnel are required to perform on a daily basis. This is work that is not actually part of their scope of practice and can distract them from their ultimate job which is direct patient care. Both sets of professionals described slightly different kinds of out of scope work but the idea that they are required to be more than just simply a doctor or a nurse in a hospital setting comes through very strongly. During the focus group

with the nurses, one of the quietest nurses who had not spoken much prior to being broached about this subject was the first to speak.

> *"Can I go first? I want to go, I want to take it out of me. Making an example, days like when we are hectic, you are a nurse, you came to work for your patients, and then now you have to be delegated to do something that is totally! Totally, it has nothing to do with nursing, it is so frustrating. You are short staffed, you have heavy patients, and your patient care comes first, I don't care who says what. Patients come first, the rest of the things, you can see them later. It's not life-threatening or anything like that and you have to do it, then if you don't do it, then your head is on the line.. I hate it! I hate it! Uhm, I'm all for extra duties for nurses is fine if we are enough, if it's not that bad, you can see days are not the same, it's not that bad, you can see today, it's not that bad, and we have students, more students than usually, but you can't be, you have three nurses and you have to do, you have baths, then you have feedings, then you have to take out patients from the bed and put them, then you still have to go and do laundry and you have to do dishes, to me, it gets to me, that's the most annoying thing ever! And we have to deal with it every day, I hate it! I have to say it, I hate it."* **FG1N4**

Whilst the nurse stopped short of actually calling the out of scope work "poison", she did use the phrase "take it out of me." Almost as if it was a cancer or a poison or even simply that this was catharsis for a practice that had been going for so long and she had no other outlet for it. It is worth also pointing out the passion of these nurses for their patients. In their mind the patient comes first and that is what they would like to do, but the fact that they are forced to wash dishes and do laundry is not something that nurses should be doing

as part of their regular work. Whilst one could argue that dirty dishes pose a potential hazard to patients, nurses form an important line of defense in the prevention of errors (Ajemigbitse *et al.,* 2013; Dornan *et al.,* 2009; Duncan *et al.,* 2012). This means their attention from the patients is divided. In that time, a scenario could arise where a medicine could be prescribed for a patient, and another nurse who is either a new locum or a new member of staff could administer it to the patient without understanding the risk.

The doctors also discussed the amount of out of scope work that they are forced to do on a daily basis. Besides distracting them from their patients, out of scope work also increases their workload and puts them under more pressure.

> *"Being a porter is within scope of practice. Being a lift technician is within scope of practice. That's on a daily basis. There is nothing outside of our scope of practice anymore."* **FG2D14**

The doctors have described having to do general odd jobs, hardware repairs and anything that was required of them to help their patients.

The concomitant factors of long shifts, lack of staff and even doing work outside the scope of practice all together increase the doctor's workload. This increase in workload has been shown to increase the likelihood of doctor's committing prescribing errors (Franklin *et al.*, 2011; Ross *et al.,*2013; Dean *et al.,*2002a; Tully *et al.,* 2009; Lewis *et al.,* 2014; Ryan *et al.,* 2014). Dean and her colleagues (2002) have shown that higher workloads have caused doctors to change their usual practices to try and save time. As a result of the high workloads and potential change in practices doctors might even forget or not check

important medicines related information such as renal function (Franklin *et al.,* 2011; Lewis *et al.,* 2014).

6.3 Types of Errors

The next theme to emerge from the focus groups was the types of errors that both sets of professionals saw on a regular basis. In most cases these were examples used to illustrate a point, this did however help to explain some of the quantitative data collected.

6.3.1 Written Records Issues

All the types of errors that came up during the focus groups were related to written records issue and included anything from an incomplete prescription to a transcription error or even dosing errors when the prescriptions were written up.

6.3.1.1 Illegibility of Prescriptions

The issue of illegibility of prescriptions and how the doctors deal with it came through strongly. The doctors often found it difficult to read their colleagues handwriting and thus they did not know what drug the patient was meant to be on or even how much of the drug the patient should be given.

> *"Did anybody mention (background in agreement) writing, what sometimes happens…. Some people write very neatly and clear and it's quite good and some people can also write and it's very difficult to read. So that also could be a problem in terms of knowing which drug it is and how much the dosage "* **FG2D8**

A number of authors have made it clear that illegible prescriptions do lead to errors (Dornan *et al.,* 2009; Ross *et al.,* 2013; Dean *et al.,* 2002a) particularly among younger

doctors. Keers *et al.,* (2015) also notes that illegible prescriptions lead to administration errors among nurses.

What do these doctors who cannot read their colleague's handwriting actually do about it? There were two important responses to this question. If they knew the patient they would make a clinical guess what the patient was on, however, if they could not guess then the more junior staff would go to their senior colleagues and ask what the patient is being prescribed. This, however, seems to be predicated on the fact that the senior staff will have the knowledge of what the patient is taking, and this may or may not be the case.

> *"In general because you know the patient, doctors are good to guess what that handwriting means. But when you can't guess and it's very difficult, you don't know what it is, you have to call the prescribing doctor or the senior doctor. In general, they know which medication the patient should be taking."***FG2D4**

The other method that they used to deal with issues of illegibility was to approach the person who had written the drug up and ask them what drug they had intended to write or approach their seniors if they had a problem with the dose of the drug. This, once again illustrates the need for more senior staff in the hospital. When asked what younger doctors would do if they were too intimidated to ask their senior colleagues they described their own technique and some of the procedures put in place to ensure correct prescribing:

> *"I will try and do the same thing if I can't see the writing. If I know the patient or I know the drug and the weight of the child then I will try to assume that this is the dose. But in my unit, we are lucky to have flow charts with their chronic medication prescribed on the chart. So most of the time, I'd go back , pull the child's file out and*

see you know this is the dose the child was on and re-prescribe it or re-write it. Especially for the clinic patients." **FG2D2**

The answer perhaps lies in the statement above. The doctor would either go to their supervisors or they would start to make assumptions based on their current clinical knowledge and level of expertise. Generally, though, they will have a set of patient notes to tell them what the patient is on. It should be noted that if the doctor goes to the patients file and then summarily copies down what is written by a previous doctor, there is a potential chance for them to commit a transcribing error and copy a potentially wrong drug or dose for their patient.

Another issue is that nurses transcribe many illegible prescriptions in order to reduce problems in their wards when they are audited. This can present a problem, as the prescription itself is not actually being checked by the medical practitioner who wrote it. As such there is a possibility that the drug can be transcribed wrongly or an unclear drug could be left out leading to transcription or re-prescribing errors (Coombes *et al.,* 2008). The nurses have, however, said that they generally will phone and follow up with the doctor if they cannot read their handwriting.

6.3.1.2 Incomplete prescriptions

Examining the above statements regarding the completeness of prescriptions, one has to understand that transcribed prescriptions are not legal until they are signed by a doctor or an intern under the supervision of a medical practitioner. This could explain the large number of unsigned prescriptions found in the medical ward in part 1 of this study. Sometimes these prescriptions go unsigned for a long period of time. And sometimes, they are never signed at all as microfilm evidence from the medical ward prescriptions indicate.

Patients are often sent up to the wards from casualty with the prescription by the emergency room doctors. Thereafter, these prescriptions are transcribed by the nurses on the ward and they await a signature from the doctor in charge of the ward. Generally, the patient will only be seen by the doctors on the next ward round and as a result their medication may only be scrutinized at that point. Sometimes, patient's prescriptions are no longer valid, but there are no doctors to transcribe out a new prescription. As such the nurses then are forced to transcribe the medicine to ensure continuity of care. This information was noted in the field journal and confirmed in the focus groups:

> *"they don't sign. It's not legal. They don't have the qualifications. Or they are just not prescribed. There was, in the ward that I work in, the unit manager, if you're responsible for medication, you do everything, the only thing that you do you can go ask the doctor to come and sign for the medication so it means I can write it up and ask that particular doctor for that day to sign it up. So even if it's going to be done, it can take days, a 24 hour thing, you give medication without a signature."* **FG1N4**

The above data would probably explain our large sample of unsigned prescriptions in all the wards that we surveyed. Clearly the doctors do not have the time to write up, and thus the current system is for nurses to do it. It seems as though, in the cases of unsigned prescriptions, nobody is ever checking these medicines to note if there is a problem with regards to transcription errors or even whether errors have been re-prescribed. Prescriptions in South Africa, much like the rest of the world, are not considered legal unless they are signed by a medical practitioner or an authorized prescribers in terms of the medicines and related substances control act (Medicines and Related Substances Control Act, 1965).

Incomplete prescriptions were noted by Ghaleb *et al.,* (2010), Stubbs et al., (2006),Keers et al., (2014) and Keers *et al.,* (2015). The incomplete prescriptions may not cause errors if they are simply not signed but if there is a problem with missing information then there is a possibility that they can cause harm. This was demonstrated in the study conducted by Dean and her colleagues (2002a) who found that prescribing errors were caused by non-documentation of patient's allergies, absence of documentation of patient's notes and lack of justification for the prescription of particular drugs in patients. Thus complete information is of vital importance to ensure safe and effective prescribing and thus more emphasis should be placed on prescription completeness by prescribers.

6.3.1.3 Dose Related Errors

Whilst the doctors only seem to point to the issues regarding illegibility and charting problems the nurses seemed to be more frank about the errors that they consistently saw on prescriptions in their respective wards.

The nurses pointed out that when newer doctors came on rotation to their wards, they often did not know what dosages to prescribe of specialized medication. Even though they were transcribing the medicines, instead of prescribing from scratch, they still wrote wrong doses. The nurses, thus, had to become a defense system and look out for the safety of patients, given the high doses or incorrect doses of drugs that were prescribed.

> *"Based on registrars that we get, I know that every year we get four rotations for three months and sometimes they are bringing very junior doctors, an MO into ICU, it's really a strain, the environment itself, doesn't understand it, the medication, doesn't understand it and then when they transcribe from what was written previously, they just write horrendous doses, and then if you are not going to check, you are going to kill the patient. "* **FG3N4**

The phenomenon of nurses being a line of defense for errors is in line with other studies that have been published internationally (Duncan *et al.,* 2012; Dornan *et al.,* 2009; Lewis *et al.,* 2014; Ajemigbetse *et al.,* 2013). The nurses were particularly helpful to prevent errors for younger and less experienced doctors similar to the doctors alluded to in the quote above.

Dean and her colleagues (2002a) showed that errors were caused by a lack of knowledge regarding the correct dosing of drugs. Coombes and his colleagues (2008) showed in their

study evidence that there were seventeen instances where the prescriber did not know the dose of the drug, or how to prescribe it. Dosing errors and not having knowledge regarding doses are a common causation for errors (Duncan *et al.,* 2012; Lewis *et al.,* 2014; Dornan *et al.*, 2009). The solution to this problem lies in education (Dean *et al.,* 2002a; Coombes *et al.,* 2008; Dornan *et al.,* 2009; Lewis *et al.,* 2014). This will be expanded on more in the section on teaching and learning

6.3.1.4 Transcription Related Errors

Simple errors regarding writing a dose that was not intended seem to be a problem. Often the doctors would prescribe a drug and mistakenly prescribe the wrong dosing while meaning to write the correct dose or route for that drug. It seems, however, that even when the mistake is corrected on the prescription is then re-written or transcribed by the next doctor incorrectly.

> *"I was nursing this patient and the other doctor came and prescribed warfarin and she wrote 50mg, and then I called him saying that "why have you written 50 mg" "ag, it's a mistake" and then I went to take 5mg then just to erase the 0, but then the next doctor who was writing the other chart, he still wrote 50mg."* **FG3N10**

The type of error listed above has been attributed to being busy or the prescriber having their mind on something else (Dornan *et al.*, 2009).

Often doctors blamed their errors in dosing, on previous doctors, because they simply transcribed what somebody before them had written and this is a problem. The problem here is two-fold. Prescribers are not taking responsibility for their actions and the other is the lack of dosage knowledge from the prescribers (Ajemigbitse *et al.,* 2013). This is

especially true, if the person who wrote it up previously to them had no idea of the correct doses, and just wrote the wrong ones down. There may even be an element of wanting to emulate the previous prescriber as alluded to by Lewis *et al.,* (2014). Lewis and colleagues (2014) noted that particularly junior doctors sometimes do what their older colleagues did because they wanted to be more like them.

> *"So usually when we do a round, I check these prescriptions and then I call the individual "what is this dose for, why are you giving so much?" "no sister it was written there on the other side" "no, why are you giving it, give me a reason, because you need to transcribe with a reason of curing something, not because it was written on the previous day. Go according to the cultures, we don't just give."* **FG3N4**

Here the ward sister is attempting to educate the inexperienced practitioners towards more rational prescribing (as an active, thoughtful choice) rather than transcribing. This is congruent with international studies, where drugs are often transcribed incorrectly from previous doctors' prescriptions (Ross *et al.,* 2013). Transcribing a patient's drug is not often seen as a task of prescribing by junior doctors. It seen as mechanical and thus it does not have the same amount of care attached to it as a situation in which a new drug is prescribed to the patient (Dean *et al.*, 2002a). Often prescribing errors related to these happen because the prescribers involved are too busy or have their mind on something else or even another patient (Dornan *et al.,* 2009; Coombes *et al.,* 2008). In the study by Coombes and his colleagues there were cases of doctors transcribing multiple charts at a time and mixing up patient's medications and even one doctor describing the act of transcribing as secretarial work. It is clear that doctors do not take the act of transcribing medicines as seriously and as a result of that errors occur.

Consistently the nurses commented that when the drugs were unfamiliar to the doctors, they transcribed what was written before. Usually there was no attempt to look up how to correctly dose the drug or to evaluate if the drug has been correctly dosed by the previous practitioner. This has been linked to less experienced doctors wishing to emulate their older more experienced counterparts (Lewis *et al.,* 2014). This seems to be a consistent finding among many of the wards in the hospital, from general wards all the way to ICU's. Less experienced registrars are implicated here, and it seems as though they are also reluctant to consult their seniors or simply do not have enough time to consult their seniors about the drugs that they are unsure of with regards to dosing.

> *"at times we do have a problem with inter-hospital transfers, the patient will come with an infusion, let's say, Prostin VR, and then it will be the new doctor in the ward. Isn't it I'm supposed to check because I don't know, sometimes the syringes are not dated, even whatever has been mixed the concentration I wouldn't know, and I would want to change the syringe. And I ask the doctor that I'm with, the registrar, because he's new he will say "let's keep it running like that" even though on the ICU chart or the medication chart he or she is just going to write Prostin, the ml that it will be running at will be the ML from the previous hospital until a senior doctor comes, if the doctor is held up in theatre, the surgeon is held up in theatre, probably that will be changed the following day or some days after, because you will ask the following day, "have you checked, have you consulted the senior doctor about this?" "oh I forgot, we were too busy admitting that one and that" and then we have problems then I knock off and this happens. I think, I don't know, inter-hospital transfers, I think the doctors from other hospitals should also write the concentration*

of whatever is being given so that when we come and change this side, its ready."

FG3N9

In this situation, the experienced nurses follow their own in hospital protocol due to lack of information about what medicine the patient has been given. One of the nurses clearly seemed upset by this situation, because she felt that they were letting a drug they didn't know about run, until a senior doctor came along. The problem is that often it would be the next day when a senior doctor came to see how the patient is doing. She suggested that younger doctors or more junior ones were less inclined to just simply change a patient's medication and preferred to let the medication continue to run until they were told otherwise.

"I agree with number 9, even here in the hospital, our theatres, they bring the patients with syringe drivers to the ward without telling you what concentration are they using, so you still have a problem there, because they will say they were given 0.5 mikes of what strength? So you have to guess, so what we usually do in our ICU, stop the concentration, start ours, and run it correctly. But if you are working with a new doctor, it's again a problem, because he wouldn't understand why are you stopping this, he would say, "leave it sister, let it run until they come" when will they come? " **FG3N4**

The problem of unfamiliar drugs being prescribed or transcribed and this leading to errors is documented in the literature (Dean *et al.*, 2002a). Transcription is the process of re-writing out a patient's previous prescription. It is worth pointing out that since doctors perceive transcription as a mechanical process, the attention to detail for making sure the patient is taking the correct drug is not strictly adhered to. As a research team we were told that

younger doctors could easily go to their older colleagues and speak to them. This does not seem to be happening in the case of transcriptions. Kennedy *et al.,* (2009) notes that often younger doctors find the weight of expectation on them that they should be able to work independently and not require help. Furthermore often the same clinicians who supervise younger doctors are responsible for assessing their competence and thus younger doctors are reluctant to show their older colleagues their lack of knowledge (Kennedy et al., 2009). Additionally Lewis et al., (2014) also notes that medical culture influences the behavior of doctors and thus younger doctors do what they need to do to fit in. This means that they sometimes choose not to seek advice because they fear looking incompetent (Lewis et al., 2014). Thus hospital culture has a role to play in the causation of medication errors. Lewis et al., (2014) also noted that the methodology required to change this culture is for older consultants and registrars to look up drug information that they are unsure of in front of the junior doctors. This will make it clear to junior doctors that it is perfectly normal to ask for help when they require it (Lewis *et al.,* 2014). Furthermore a number of studies have noted that junior doctors also find it difficult to change and check another prescription written by a different prescriber (Coombes *et al.*, 2008; Ross *et al.,* 2013; Page *et al.,* 2008)

The way to solve this problem seems to be demonstrated in one of the wards, where the nurses have been given a bit more freedom by the specialist doctors and professors who run the ward. They are allowed to not accept any medication that the patient is on from outside their ward and instead start the patient on their own medication as per their ward agreed protocol for the management of their patients.

> *"You know, now it's better for us because we are working with the intensivist and the professors they have given us that leeway of not accepting any medication from*

outside, use our protocol whereby we know where we are, you stop that one, you start with our protocol."

Whilst this is a good idea, it can only be done if the nurses themselves are well trained and have a good grasp of the concepts of pharmacology and clinical pharmacology. This will reduce the pressure on doctors but may lead to more unsigned prescriptions.

6.4 Inter-professional Practice

Issues regarding inter-professional practice specifically with regards to, team function were a major theme that was raised by all the focus groups. A lot of the issues seemed to be centered on a lack of communication usually between doctors and nurses but one of the problems that was identified in all of the focus groups is that there is a percieved need for a dedicated clinical pharmacist on each ward. A ward pharmacist or a clinical pharmacist has been shown as line of defense against prescribing errors (Coombes *et al.,* 2008; Ajemigbetse *et al.,* 2013; Lewis *et al.,* 2014; Duncan *et al.,* 2012; Dornan *et al.,* 2009; Ross *et al.,* 2013)

6.4.1. Team Function

6.4.1.1 Communication between Professionals

The doctors felt that were no problems with regards to communication between themselves. They felt as though they could communicate easily with one another. One has to bear in mind that the younger doctors were in the presence of their older counterparts when this was said and thus may have felt intimidated to disagree. This is in contrast to what the nurses described above, where the doctors seemed to be afraid of asking questions of their senior colleagues.

"It's generally good communication and its generally easy to go to your seniors like no-one really has an issue going higher up or asking for help from your seniors." **FG2D14**

Doctors who are working as part of the same team may communicate easily with one another but when it comes to different specialties it seems as though these doctors do not communicate well with each other. As a result the nurse may be caught in the centre and there could be miscommunication and potential harm to patients.

"uhm, and yes it is, I think with the two groups, we are working with from one discipline and from the other, it is difficult, because I think each discipline wants the patient to get better but it's often two different way to do something, uhm, and then as a nurse, I think that you are put in a problem and incidents have happened where you try to be in the middle and yeah it is a problem." **FG2N6**

With regards to speaking to nurses one of the doctors pointed to the fact, that she found it very easy to communicate with the nurses as they all spoke the same language, and she could therefore converse with them in their own language.

"Well personally for me I also have the advantage of language so I can speak to the sisters in more languages than the other people can. But I have no problem communicating with the sisters." **FG2D9**

The communication between the doctors and the nurses, however, seemed to be problematic on both sides. The doctors seemed to suggest that the level of the nurse they conversed with was important. This is probably correct, as the nurses have alluded to the fact that their wards are largely made up of enrolled nurses who are essentially still learning.

It seems to be the cases that some doctors believe all nurses are the same just because they wear the same uniform and do not realize that all nurses do not have the capabilities of carrying out their orders and still expect whatever they have communicated to be done. Thus an enrolled nurse (EN) for example does not have the same knowledge or skill set as a registered nurse. Also the responsibility of an EN is different from that of a registered nurse.

> *"There is a problem with communicating with sisters as long as you are aware of whom you are communicating with; you have to ensure that you speak to a senior nurse. Mistakes that junior people make is that they pick on anybody wearing a white outfit and communicate a complicated order to them, you have to know who to speak to and the more senior you are, the more easier that is to identify and I think the more junior you are there is risk of making mistakes that you communicate to somebody who isn't really in a position to understand what you are saying or to carry out the order. And you rely on them to relay the order up to their senior and that may not happen and I think that that's something we have experienced."* **FG2D1**

The nurses have also suggested that the ego of the doctor seems to come into play when they try to talk to them about an error that the doctor has committed. One nurse suggested the only reason that she is able to talk to the doctors easily in her ward is because she has a good relationship with them. In general though, the nurses agreed that the consultants and professors generally treated them the best and were the easiest doctors on their wards to talk to. With the ease of communication of the more senior doctors, its seems as though the nurses would go to them if there was something wrong.

> *"I do support number 2 and number 8, uhm, I just want to say from a ward point of view, where I've worked, what we do is, uhm, you will always have egos that I think*

come into play with communication, what we do in the ward when we have a problem with communication is that we will go first to the person who prescribed it and if they've written something an error, bring it to their attention, uhm, what we are very lucky to have is we have good consultant so when there is something that hasn't quite been done correctly and when we are not getting satisfaction from the individual person, we will then go to our consultant," **FG3N1**

It seems as though the younger doctors are not as willing to listen to the experienced nurses and they tend to become aggressive when a more experienced nurse might point out to them a mistake that they are making. They seem to be threatened by experienced nurses on the wards.

"We've all experienced it sitting here. I find that the more experienced the nurse is, the more threatened the doctors are, and they tend to get aggressive. I'm often asked by the senior doctors in these ICUs, I must come down and spend more time there, I said I do spend a lot of time there, but if you have babies at the bedside. If I point out to a baby doctor that no we actually do it like this, he's threatened, so immediately I'm the enemy, and you get tired of that. And that's how I feel." **FG3N2**

The question to ask is why the younger doctors feel more threatened by the experienced nurses? One of the nurses in the focus group was honest, that sometimes experienced nurses tend to behave in a manner that is unprofessional. As can be seen by the attitude displayed in the quote above, they tend to scold the younger doctors, and even in some cases go so far as to verbally abuse the doctor, when they have done something wrong. There are even claims that the new registrar or member of staff maybe unqualified to do their job properly.

"I think that is such an important thing to do because in ICU there are a lot of prima donnas trust me and when a registrar comes in and he hasn't written or calculated something correctly or whatever, they'll stand at the bedside and shout and scream at the registrar and put him down like he is such an idiot, one even asked if he bought his degree. And this is common place, it's not a once off thing, this is how they behave in ICU. Shouting at him and telling him and telling why did you put this? This patient doesn't need this and it's abusive and really counter-productive, even although, what she was saying was correct." **FG1N1**

One cannot simply say, doctors and nurses must treat each other with respect, or even the fact that there is a vicious cycle here. The doctors treat the junior nurses badly, and these could be the same nurses who one day when they become senior nurses, then treat the junior doctors with equal disdain. The idea to solve the problem may lie in the education of both these groups of professionals. The nurses favoured the idea of some kind of communication training, which could perhaps make it easier for both groups to communicate with one another. It could also be suggested that such training could also help specialist doctors to communicate more effectively with others from different specialties and thus not leave the nurse and the patient in the middle, with the resulting ill effects on the recovery of the patient. The idea of communication training to help reduce errors has been suggested as possible solution by Lewis *et al.,* (2014).

"There's a decent way of saying wouldn't you rather look at it like this or wouldn't you ,uhm , you know we have a protocol here and this is the way that we would do it unless there's some reason why you want to do it differently but this is …and explain. I think the whole hospital, not just on the prescription side of things needs

communication skills classes. There's no need to scream and shout at people, hey? True?" **FG1N1**

6.4.1.2 Ward Pharmacist

All the professionals in the focus groups made it clear that they would prefer to have a ward pharmacist to help them with medicines related queries and prescription problems. The jobs varied from ensuring the authenticity and legality of prescriptions, to ensure ensuring the correct amount of stock is available in the ward at all times. The doctors did not seem oppositional and instead wanted to have a pharmacist to check their prescriptions so that errors could be reduced substantially. The problem at this hospital is that in the past there were pharmacists on the ward, but now all the pharmacists work in the dispensary, and dispense medicine as bulk stock to the wards. They only see and dispense outpatient prescription and do not see the inpatient ward prescriptions. Thus, there is a level of defence now missing, and it is easier for a serious error to take place.

"I would like to second number 2. We need pharmacists, when I arrived here at XXXX XXX Hospital, we had pharmacists where they will query if the doctors prescribed something and they would ask why this has been prescribed for such a period of time or can't we change this to the other drug." **FG3N9**

The nurses pointed out that whilst they understood that the pharmacy is busy and does not have enough staff to go around and to send to them, they would even be willing to accept an intern or a community service pharmacist, who is mentored by an experienced pharmacist, because this could reduce the number of errors on their wards.

"We understand that pharmacy, they are short staffed also, I don't know if they use interns, maybe if they can place one but somebody must mentor that person because as number 9 has said we can have less medical errors." **FG3N8**

The doctors pointed out that they appreciated the pharmacists phoning them when there was a problem with an outpatient script, there was little opposition to speaking to pharmacists about prescribing errors. The lack of opposition to having a pharmacist, could be used as a start for the justification to have a pharmacist on the ward. In addition to that, they also wanted a pharmacist on the ward to help reduce the number of errors.

"I feel that in any good hospital, there should be a pharmacist allocated to each ward who comes around and checks the drugs. Now we have 27 kids that each drugs are taken and these kids are on five/six meds so that's a lot of work but nevertheless I've seen many errors picked up and our pharmacist downstairs here regularly phones us and says you've written up the wrong dose, what's going on (number 2 interjects "everyday", she's the only one that does it and if she's not there (number 2 interjects again "yeah, everyday",)" **FG1D1**

"Not all doctors are trained with an attitude of accepting advice, and to answer the last part of your question to who would you want in the MDT. I think under the circumstances of listening to a number of my colleagues, with junior and inexperienced doctors rotating around the different areas, its increased pressure on us, and I would suggest having a pharmacist on the team to help in guiding." **FG1N1**

In the international studies done on the topic, doctors sometimes used the fact that having a pharmacist around to catch their errors was a defense that allowed them to commit

prescribing errors because the pharmacist would pick it up (Coombes *et al.,*2008; Dean *et al.,*2002a; Franklin *et al;* 2011; Ajemigbetse *et al.,* 2013; Lewis *et al.,* 2014; Duncan *et al.,* 2012; Dornan *et al.,* 2009; Ross *et al.,* 2013). Despite this in all of these studies the doctors who had committed prescribing errors had a good working relationship with their ward pharmacist or clinical pharmacist and often praised them for picking up on the prescribing errors (Coombes *et al.,* 2008; Dean *et al.,* 2002a; Franklin *et al.,* 2011; Ajemigbetse *et al.,* 2013; Lewis *et al.,* 2014; Dornan *et al.,* 2009; Duncan *et al.,* 2012). It was even suggested that pharmacists come on ward rounds with the doctors in the hope that they could sort out medication related problems at the bedside (Coombes *et al.,* 2008). A study by Miller *et al.,* (2011) showed that when pharmacist attended ward rounds their patient interventions were also more likely to be accepted by the physicians and senior staff members.

So, how can pharmacists (who are already present in the healthcare system) be utilized to reduce prescribing error? The obvious answer here is to have clinical pharmacists on ward. There are inherent problems with this in South Africa. The government has posts available for clinical pharmacists, but the role of the clinical pharmacist in South Africa is still under discussion and the relevant legislation must still be passed. The South African Pharmacy Council has published a proposed set of standards that they want a specialty clinical pharmacist to be trained in (South African Pharmacy Council, 2014), but this has still not been passed into law. That said, simply using an experienced pharmacist would be more than sufficient for now, and for the nurses they are willing to accept a more junior pharmacist as long as there is mentoring by a senior pharmacist. Studies by Franklin *et al.,* (2011), Ryan *et al.,* (2014), Ashcroft *et al.,* (2015) have used ward pharmacists to identify

prescribing errors as part of their studies. This indicates that pharmacists with knowledge of the ward can be used to help identify prescribing errors.

It is clear that a line of defense available internationally, to prevent in-patient prescribing error is missing in this hospital. Without this line of defense, the only line of defense now is the nurses. So instead of having both nurses and pharmacists checking a patient's prescription, only nurses are doing it, and they are also in some cases forced to transcribe these prescriptions as well. Thus the hospital should have a pharmacist posted to each ward. The pharmacist would be in charge of ensuring the legality and the appropriateness of medicines usage. The pharmacist could also go on rounds with the doctors to ensure that there is good communication between the senior and junior staff in relation to the medicines that are prescribed. The pharmacist could also advise junior doctors on the correct method to prescribe medicines that they are uncertain off or have never prescribed before (Lewis et al., 2014; Dornan et al., 2009). Clinical pharmacist can also lead training into prescribing for junior doctors and those in their final year of study (Ward and Wasson, 2016). In their study, most future prescribers (i.e. students in their final year of studying medicine) were appreciative of the training and the training was helpful to them because they also received individualized attention. Pharmacists have been noted as a defense against errors reaching a patient and also in picking up prescribing errors by Ajemigbitse *et al.,* (2013); Lewis *et al.,* (2014); Coombes *et al.,* (2008) and Dornan *et al.,* (2009). However, the literature suggests, that there is often very little feedback given to prescribers when they make mistakes (Coombes *et al.,* 2008; Dean *et al.,* 2002a). Studies that have looked specifically at providing feedback to prescribers have suggested that pharmacists provide one on one feedback to prescribers regarding the errors they made (Franklin *et al.,* 2007;

Bertels *et al.,* 2012). Thus the pharmacist who is appointed to the wards should be continuously giving feedback to the prescribers with regards to specific prescribing errors as well as teaching them about safe and effective use of medicines.

6.5 Teaching and Learning

Issues regarding teaching and learning were brought up by both groups of professionals. The three main categories were: knowledge gaps, didactic instruction and work integrated learning. Both the doctors and nurses acknowledged the problems in training prior to working and the problems it led to.

6.5.1 Knowledge gaps

6.5.1.1 Emphasis on Clinical Knowledge over Pharmacology Knowledge

The doctors admitted that in medical school and postgraduate studies they are trained to think diagnostically first and not worry too much about the patient's medicines. The emphasis was on them making the correct diagnosis and as a result they did not have as much knowledge as they would have liked about the medicine they were prescribing for the patient or even the current medication that the patient was taking. It is as if the knowledge about medicine needs to be self-taught and if that is the case, some of them have not taken it up the way that they should and as a result of that they have distinctive knowledge gaps.

> *"We were encouraged to learn the clinical side first and then medicines come after"*
>
> **FG2D8**

There is a clear chink in the doctor's armour of knowledge that is created by making doctors learn the medicines knowledge on their own. Especially with regards to interns, medical

officers and registrars they have such limited time and are constantly working there is often little free time to improve their knowledge in this area. This was demonstrated by both Coombes *et al.,* (2008) and Lewis *et al.,* (2014) who noted how overworked doctors are.

Coombes *et al.,* (2008) noted a similar trend in Australia. The emphasis for young doctors seems to be on clinical knowledge rather than on prescribing. Lewis *et al.,* (2014) also noted the lack of knowledge around prescribing medicines in prescribers who committed prescribing errors. Thus there needs to be greater emphasis on learning medicine related knowledge to ensure effective and safe prescribing of medicines (Lewis *et al.,* 2014; Ross et *al.,* 2013; Dornan *et al.,* 2009).

6.5.1.2 Lack of Trade Name Knowledge

The younger doctors acknowledge that they always learnt drugs via the generic name and as a result they were caught by surprise when they came to the hospital and people only spoke about drugs via their trade names. If they used generic names with the nurses, there would be a problem in communication.

> *"I do remember that the only problem that I had a problem with coming from school into working was that we were taught to say ceftriaxone and you would be killed if you ever said Rocephin but I didn't even know what Rocephin was when I came across here. And I came across and wrote ceftriaxone and the sisters didn't know what Cefriaxone was. So that was the only thing that I struggled with when I came here."* **FG2D9**

It is worth pointing out that the nurses wanted the doctors to prescribe via generic name and not by trade name, to make it easier for them to use whatever generic was available at the hospital at that time.

> *"The other problem when talking about prescriptions and that is that we don't always have the drugs written in the generic name and its written in the trade name and it depends often the drug is being tendered for so you may get the name for the drug Lasix for the next few months then another company comes in and they will give it another name and then people won't be able to find it or don't ask and then the patient doesn't get it or something sounds similar to that so the patient gets that but in our in intensive care, when we are taught with giving medication and even in undergrad, you are supposed to check all of your medications, it doesn't matter what rank you are, with a second person, because everybody is so busy running around…."*
>
> **FG3N1**

Prescribing in general should take place in generic name, especially here in South Africa where doctors are encouraged to prescribe via generic name. This rule has been set down in the national drug policy of the country. The problem here seems to be that the doctors are prescribing via trade name because of their perception that the nurses will only understand that way, and instead the nurses want prescriptions via generic names. Therefore, this problem of knowledge gaps can lead to miscommunication, specifically if a trade name and a generic name of a drug are very similar. If this is coupled with the poor handwriting of the doctors, this could easily lead to an error. This was noted as a problem in the field journal where a prescription with an error had a drug prescribed as "Azithromax" 500mg daily. This

evidence of the fact that the prescriber was caught between the use of the generic name, azithromycin and the trade name Zithromax®.

This discussion over whether to prescribe via generic name or trade name with different people doing different things has led to errors in the past. Dean and her colleagues (2002a) noted a case where an intern mixed up the trade names of two drugs and thus prescribed the wrong one. This occurred even after the pharmacist had written the generic name alongside the trade name of the drug previously. Thus, only generic name prescribing should take place and communication between doctors and nurses with regards to medicines should only take place on a generic name basis (Brits *et al.,* 2017; Department of Health, 1996).

A suggestion in the hospital is to ensure all prescriptions and discussions about medicines take place on a generic name basis. This will avoid confusion and prevent prescribing errors from taking place. Prescribing via generic name will reduce confusion and prevent prescribing errors.

6.5.1.3 Lack of Knowledge of New Doctors

The nurses were at pains to point out that the new registrars and medical officers often have gaps in their knowledge when they first come onto the ward. There is a clear lack of knowledge of drugs that are used in critical illnesses and even how to use them in these patients. There is a twofold problem here; there is the lack of didactic instruction prior to qualifying as well as the knowledge gaps of the doctors once they are registered as full health professionals. These gaps are clearly not filled until these registrars become more proficient through experience in that particular area.

"I would like to support what number 1 is saying but I would also like to add, the registrars have a specific amount of experience, we actually work with newly qualified doctors in community service, and I think that critical illness is not taught in the medical programme, so understanding the critically ill drugs I don't know where they get it from, maybe when they graduate, it will automatically, but they lack that knowledge and the nursing staff have to then guide as to what should be prescribed or not prescribed." **FG3N2**

The concept of newer or less experienced doctors lacking knowledge with regards to medicines has been demonstrated by numerous authors (Coombes *et al.,* 2008; Dean *et al.,*2002; Dornan *et al.,* 2009; Lewis *et al.,* 2014; Duncan *et al.,* 2012; Keers *et al.,* 2015). In the study by Coombes and colleagues (2008), twelve out of seventeen of their interviewees felt that they lacked the knowledge, while sixteen participants out of twenty four in the study by Dean and colleagues (2002a) felt that they lacked both the knowledge and experience required for prescribing. Lack of knowledge was also demonstrated as a reason for prescribing errors taking place by Lewis *et al.,* (2014). All of these studies, the lack of knowledge and experience lead to these junior doctors committing prescribing errors. Similar circumstances were also noted by Dornan et al., (2009). Furthermore in the study by Duncan et al., (2012) noted that newer and less experienced doctors lacked the clinical knowledge to prescribe drugs and were sometimes not even aware of what they were prescribing or transcribing.

Junior doctor's lack of knowledge and experience is not an uncommon scenario around the world and thus South Africa is not alone with regards to this phenomenon. The discussion

regarding what to change in the curriculum will follow in the next session regarding didactic instructions.

6.5.2. Didactic Instructions

Problems resulting from didactic instruction during their respective university careers were discussed and made mention of by both groups. The nurses and doctors felt there was lacking information with regards to didactic instruction from the time that they were students. The issues raised by the doctors included: not being taught clinical pharmacology of drugs, some role play teaching, lack of training on how to write prescriptions. The nurses highlighted a lack of clinical pharmacology training and a lack of role play teaching as their main issues.

6.5.2.1 Lack of Clinical Pharmacology Training

Both the doctors and nurses felt their pharmacology training was deficient during their university careers. The older doctors acknowledged that the system in place at the medical school now was somewhat better than the system that they were a part off. They were taught the pharmacology completely without a reference point with regards to pathophysiology of the disease. This made the pharmacology more applicable to clinical scenarios and situations.

> *"Are you talking about pharmacology? I found with respect to the pharmacologists and our pharmacology in fourth year was an absolute disaster, I don't understand. I didn't learn it particularly well, I found it difficult to apply and to understand these drugs when you haven't really learned the diseases and what you're actually trying to do with the drug. Now that the programme has changed maybe it's different, I don't*

know. For example, number 2 gave us a talk this morning which she explained the pathophysiology and then you could understand how the drug worked. Simply understanding drug structure biochemistry, I'm very bad at that sort of thing, I never got that. That's my contribution." **FG2D1**

Whilst the younger doctors had acknowledged that the system had changed and now drugs are taught at the same time in the same week as the disease, they brought up the fact that were given very little practical knowledge on how to prescribe the drugs that they were being taught, like what doses the drugs should be given at or even how they should calculate the doses of drugs in specialized groups of patients. They also brought up the fact that they often did not study the pharmacology, because the integrated nature of their exams allowed them to concentrate on other subjects and leave the pharmacology for the morning before the examination. Again proving the point that medicines and medicine knowledge is not prioritized in the training of a doctor as clinical knowledge.

"I think it is, like number 2 said, taught a lot better now. But you don't get as much pharmacology in the blocks in the 3rd, 4th, and 5th year, like you get 2-3 weeks in PCMS and a couple of days in the rest of the block so it's like one lecture per block. So it's still not enough and there isn't much focus on it. Pharmacology is probably one of the lectures you study the morning of the exam because it's just one lecture in the block and you don't get that much attention paid to it." **FG2D14**

"I think I remember a 3 week block in pharmacology in our undergrad training and I don't remember learning doses." **FG2D3**

"You only get them in textbooks. And rather more importantly they never taught how to give the medication. Some of the medication you give by infusion. There is a dose it might perhaps be mcg/kg per minute, You get here and sisters don't know how to give the medicines. If you are in here you are also clueless so never." **FG2D15**

From the above quote it is not difficult to deduce that the doctors who do not have this knowledge rely heavily on their nursing colleagues. Whilst this maybe a good idea in most cases, there are examples in the literature where doctors have committed errors by listening to their nurse colleagues (Ross *et al.,* 2013; Dornan *et al.,* 2009). Both these authors make mention of scenarios when younger doctors are told to prescribe medicines by nurses that were either unwarranted or a duplication of previous medicines and thus lead to prescribing errors (Ross *et al.,* 2013; Dornan *et al.,* 2009). The problem with not having the knowledge from the university level is as result of the emphasis being placed on teaching doctors clinical medicine and not enough about the medicines that their will have to prescribe to treat their patients.

Because the junior doctors are not taught about aspects of dosing and how to calculate doses at medical school, they have to learn this information on the job.

"[doses] that was also just being taught on the job you were never actually given a lecture on the doses. You just have to pick it up as you went along it was never specifically taught to you." **FG2D14**

Gokhul et al., (2016) studied dosing calculations in paediatric ICU in South Africa and noted that only six out of eleven healthcare professionals were able to do dose and other related calculations and get a perfect score. Of the remaining healthcare professionals who

participated in this study, eleven (44%) committed three or more errors and this number was equally a problem between both medical and nursing staff. The problem of not knowing how to calculate or dose drugs seems to be a problem not just in South Africa but around the world as well. These are regular causes of errors that have been cited by Dean *et al.,* (2002a), Coombes *et al.,* (2008), Franklin *et al.,* (2011), Ryan *et al.,* (2014), Ross *et al.,* (2013), Likic and Maxwell (2009) and Duncan *et al.,* (2012). Coombes *et al.,* (2008) notes that learning how to dose medications is meant to be taught and medical school as well as on the job, but some of the respondents in their interviews told them it was not taught at medical school. Dean and her colleagues (2002a) conclude that this sends out the message that doses are not important even though dosing errors can be potentially serious and thus dangerous for the patient if they are not intercepted. Interns and junior doctors are placed in the position to prescribe medicines without have the technical knowledge of how to do so (Dean *et al.,* 2002a). One of the respondents in the interviews that Dean and her colleagues (2002a) conducted made special mention of the fact they are not taught doses at medical school, and it is something that you have to pick up on the job. This is not dissimilar to the situation here in South Africa, when interns, medical officers are forced to learn doses of drugs on the job without being taught to them originally at medical school. In the study by Coombes and his colleagues (2008), they have 17 interns who committed a prescribing error from not knowing the dose of the drug, because they had not prescribed the drug before. In an attempt to reduce errors by senior doctors being prescriptive and telling junior doctors what do, Coombes and colleagues (2008) point out that this robs the junior doctors of their chance to learn on the job because they are often being told what to do. Coombes and colleagues (2008) also point to studies showing that improving drug knowledge of the prescriber results in a decrease in medication errors. Likic and Maxwell (2009) point to the

evidence that more and better prescribing training will reduce patient harm from medication errors. Thus the skills of safe prescribing must be a core component of the curriculum of doctors.

The nurses were also unhappy about the way they were taught pharmacology. It is clear that one of the nurses had a similar complaint as the doctor above, in that their pharmacology classes were not clinically relevant enough and was filled with too much basic science. It did not give the requisite skills that they needed to work effectively on the ward.

> *"I think that certainly the level of student nurses and registered nurses doing postgrad courses, applied pharmacology has got to be a real place, I think very often when it's put together in the curriculum, and its put together as pharmacology but then pharmacology should be for the pharmacologist. Applied pharmacology is what we should be doing, how do we use a drug, how/should it be mixed, what safe doses, that sort of thing is far more important than knowing whether a cell membrane adheres to the cell membrane or moves through the cell membrane. Let the pharmacologist know that."* **FG3N7**

There is an inherent problem here. If the doctors who do not have sufficient knowledge about how to prescribe the drugs are turning to the nurses who also lack clinical pharmacology knowledge, the possibility of committing a prescribing error increases. In this scenario the doctors are learning on the job vital medicines information, from nurses or their senior colleagues (provided they are not intimidated by them or willing enough to ask questions).

Coombes *et al.*, (2008) also points out that the knowledge of safe prescribing is also required by all the members of the healthcare team and not just doctors. Clinical pharmacology knowledge by nurses will help to ensure good prescribing habits and also avoid administration errors (Keers *et al.,* 2015).

It is clear that the curriculum for both nurses and doctors needs revising, to ensure that the aspects of relevant clinical pharmacology are taught so that safe and effective prescribing can take place. Thus, one of the suggestions that must be put forward and has been put forward by Coombes *et al.,* (2008) is that the curriculum of medical students must be redesigned to teach them aspects of safe and effective prescribing. We suggest that this must also take place for the nurses as well. The curriculum must cover aspects of dose calculations and dosing of medicines, and should place equal emphasis on dosing of drugs as there is on clinical skills and aspects of clinical medicine. After all, there is no point in having the diagnosis, but harming the patient through treatment. Dornan *et al.,* (2009) noted that clinical pharmacology must be a part of the pharmacology course of medical students while they are at University. This should be in conjunction with classical pharmacology and more hands on prescribing (Dornan *et al.,* 2009). One of the participants in Dornan and Colleagues (2009) study even suggested that junior doctors be made to go on a prescribing course similar to that that is a legal requirement for independent non-medical prescribers.

6.5.2.2 Role Play in Teaching

One of the junior doctors made mention of a block period where they actually got to role play as interns and were allowed to prescribe medicines to a patient that would be countersigned by a senior doctor. The idea behind this role playing was to give them exposure to prescribing medicines for patients whilst still having the safety net of somebody watching over them.

> *"We had intern blocks in 5th year where we acted as interns and we were prescribing but we were being counter signed either by the intern or the reg. and then I remember in final year in my paediatric block specifically we were also prescribing on charts and being counter signed but it was only two blocks out of six."* **FG2 D5**

The idea of having an intern block to teach prescribing in theory sounds very good but has also resulted in prescribing errors. As the study by Dean *et al.* (2002a) shows us, a hospital included in their investigation had one such programme where the final year medical students were allowed to write discharge prescriptions for patients, provided it was checked by a more senior doctor. The problem with this system is that, the more senior doctors to the medical student is probably the intern or the medical officer, and they were often very busy and would just vaguely check through the prescription that was written out by the medical students and thus errors were reported. So the doctor would check if the correct drug was chosen and filled in, but then might not check if the doses were correct or if the correct dosing intervals were written in as a result of being too busy and thus errors occurred (Dean *et al.,* 2002a).

There was however, no role play teaching mentioned where the student doctors swopped roles with the nurses to understand what they go through so that they could understand each other and learn to communicate better. The nurses suggested that this would probably be a way to help improve communication between them and the doctors.

Coombes *et al.,* (2008) points out that there must be space in the curriculum for safe practice of prescribing, and this must become a core component of the medical education curriculum. While role play is important (for example the intern blocks), especially in light of the lack of clinical pharmacology teaching, it must have a robust system in place, to prevent errors. The problem is that doctors are generally quite busy during their shifts and have high patient loads. This has been discussed before. Therefore in order for a system like role playing to work effectively, staffing issues must be sorted out quickly and correctly. The addition of a pharmacist to the staff might be another useful addition, as the literature describes pharmacists as a line of defense to prevent prescribing errors (Dean *et al.,* 2002a; Ajemigbetse *et al.,* 2013; Lewis *et al.,* 2014, Coombes *et al.,* 2008; Dornan *et al.,* 2009).

6.5.2.3 Writing of Prescriptions

The doctors acknowledged that they were never formally assessed on how to write a prescription but they were given lectures on what were the legal requirements for a prescription to be valid. They were not taught, however, how to fill in a prescription for a hospital setting, or even had an experience of writing a prescription during their time in the classroom setting which allowed them to feel a bit more confident before having to do it consistently as interns.

"I think we did get those lectures like how to write a proper prescription. You know it has to be dated and titled and have all of the information so we did get told that at some point. I do remember that lecture." **FG2 D14**

This means that as young doctors they did not have any experience on how to write a prescription, other than possibly their intern block which they alluded to above.

This situation of receiving no training or minimal training with regards to prescribing is not new in the literature. In the study by Coombes *et al.,* (2008), eight of the interns who had committed a prescribing error reported having never received any training in prescribing, while four of them reported having had minimal training with regards to prescribing. Seven of the interns who committed errors received some training during an induction programme into the hospital. There was a similar complaint regarding training on how to write prescriptions and being encouraged essentially to learn it on the job by participants in the study by Dean *et al.,* (2002a).

The above situation clearly shows that a lack of knowledge about how to write prescriptions or prescribe drugs does contribute to errors, and that South Africa is no different from the United Kingdom or Australia, where interns or junior doctors have to learn how to prescribe medicines for patients on the job, instead of the safer confines of the classroom. An induction programme, could be a solution, but it still resulted in errors in the investigations by Dean *et al.,* (2002a) and Coombes *et al.,* (2008). Lewis *et al.,* (2014) and Dornan *et al.,* (2009) noted a similar problem in their study, and suggested that more emphasis must be placed on the practice elements of prescribing, including the fact that younger doctors must be given an opportunity to practice prescribing and using of reference material.

Furthermore the suggestion by Dornan *et al.,* (2009) is that the curriculum at medical schools be changed in order to allow more time for medical students to have practical prescribing. The junior doctors in the study noted that more should be done during their time at medical school by allowing them to practice prescribing even if it just re-writing a patients chart. This would allow them to have more experience practicing actual prescribing (Dornan *et al.,* 2009)

6.5.2.4 The Need for an Application

The doctors expressed the need for a drugs application similar to the primary care application or the HIV and TB guidelines applications that are now available in South Africa. They said that having the South African Medicines Formulary as an application on their cellphones, would be ideal for them, and would help them in their practice. The need for resources to assist with prescribing has been documented by Ajemigbetse *et al.,* (2013).

This could potentially make it easier for junior doctors to learn medicines related information and also allow them to quickly and easily check information that they were unsure off, even if they were intimidated by their seniors. The use of applications in the developing word to reduce dose related prescribing errors was demonstrated by Segal *et al.,* (2015), who noted a 40 percent reduction in dose related prescribing errors with the use of a specifically constructed health app. It could help prevent prescribing errors like incorrect doses and dosage regimens and prevent doctors from transcribing the drug information incorrectly simply because they are unsure of the drug.

CHAPTER 7: FINAL CONSIDERATIONS

7.1 Conclusions

This is the first South African study to compare four different ward types with regards to prescribing error in a formal way using a validated international methodology. As noted in the discussion, the medical, surgical, psychiatric and paediatric ward percentage prescribing errors were higher than most of the international studies that they were compared with. There were variations in the occurrences and types of error scenarios between the adult wards that were compared and there was a statistically significant difference between the numbers of errors in the adult prescriptions when compared to the paediatric prescriptions. The paediatric prescribing error percentage was higher than that of the adults and was expected given the postulations made by previous authors on the subject.

The multinomial logistic regression and the relative risk ratios correlated well with each other and helped draw comparisons between the wards in this study. For one error on a prescription the relative risk ratio was higher in the paediatric ward when compared to medical ward and this was significant. When comparing the medical ward to the psychiatric ward and the medical ward to the surgical ward for one error relative risk ratio was lower in these two wards, indicating a lower risk of error. For two errors on a prescription the relative risk for ratio was higher in the psychiatric ward and the paediatric ward when each of them was compared to the medical ward. There was no significant different for two errors when comparing the medical ward to the surgical ward. For three and four errors on a prescription the number in the sample was too low to draw any conclusions.

In terms of the types of error scenarios, unsigned prescriptions were higher in the medical ward and could be linked directly to nursing being forced to transcribe patients prescriptions so that they can be current. These transcribed prescriptions are then not signed by prescribers and as a result of that they remained unsigned in the microfilm records. The nurses have tried to place emphasis on trying to have these prescriptions signed so that when they are audited this is in order, however, one should questions the need to place importance in auditing over the validity of a prescription for a patient. The large numbers of ambiguous prescriptions could be linked to prescribers being overworked and not having enough time to write clear and unambiguous prescriptions. There is also a problem on the wards of poor documentation by the professionals involved and this could reinforce this kind of error. Some of this problem can also be linked to the poorly constructed charts which leave very little space for proper prescribing and charting. Often both the nurses and doctors are forced to perform tasks outside their scope of practice all in the interests of their patients wellbeing. This takes away time from activities that they should be doing like keeping clear notes and writing complete and unambiguous medication orders.

Dose related errors were linked to a lack of knowledge on the part of the prescribers and the lack of training to hone their prescribing skills prior to them coming to work in the hospitals. Equally all pharmacology and clinically related pharmacology type errors e.g. underdosing of medicines, overdosing of medicines, prescribing clinical contraindicated medicines etc can be linked to a lack of clinical pharmacology education given to doctors at medical school. It is clear that more influence is placed on clinical pathophysiology in medical school than clinical pharmacology and therapeutics. This could be a potential area

where a pharmacist on the ward could be of some assistance. Both the doctors and the nurses in their focus groups have welcomed the idea of having a pharmacist on the ward to help reduce errors and ensure that all medicine related queries can be solved quickly. International studies have shown that pharmacists can be a line of defense and help to prevent prescribing errors and medication related errors from reaching the patient and thus reduce potential harm to the patient. Pharmacists on the ward could also act like mentors to younger prescribers and help them in developing their prescribing skills through clinical pharmacology related workshops. The education system needs changes in curriculum. It is evident that a lot of emphasis is placed on the principles of diagnostics and clinical medicines and not enough emphasis in training, is placed on clinical pharmacology and therapeutics. This needs to be changed. The principles of safe and effective prescribing must be taught and practiced long before medical students get to become interns. Having a 3 week block or a lecture on how to write a prescription is not enough. Whilst dosing errors have been linked to problems in the education system at university, an innovative way to solve the problem for prescribers who have already completed university can be through the use of mobile apps which has been proven to be a successful way to curb this type of error in a developing country.

The problem of misspelling of drug names can be linked to being caught between prescribing via trade name or generic name. It is clear that similar to recommendations set down by the National Drug Policy prescribers wish to prescribe via generic name and not by trade name, however this creates confusion with the nurses. Ultimately, a redesign of the prescription chart with space for both the generic name and the trade names for the medication could solve this problem and reduce the confusion on the part of the prescriber

and also help the nurses to learn the generic names for medicines if they are unaware of them.

There is also a clear lack of staff on the wards as overworked doctors and nurses. Consequently there is a lack of supervision for younger less experienced doctors. Younger doctors, need more staff to supervise them. It is clear that the hospital is doing the best they can to have people on call to supervise them, with registrars and medical officers working 24-28 hour shifts at a time. The supervision of prescribing and ensuring medicines are prescribed properly and meet the legal requirements can be done by the ward pharmacist if one was placed on the wards. They could ensure that this is done correctly by all the stakeholders involved, and in so doing reduce the amount of work these supervisors have to do.

Transcription related errors will require greater knowledge on the part of the prescribers so that errors or mistakes are not made in the first place and also more time needs to be freed up so that the subsequent prescribers are not rushed into making the same mistakes as the previous person in effort to get done. When a doctor is hurried or rushed into prescribing or transcribing a medicine this is when errors can take place (Dean *et al.,* 2002a). This will again require more staff and a better functioning system in the hospital so that prescribers are not forced to become 'handyman' or porters to ensure that their patients get the service that they required. At the end of the day, it is clear both the doctors and nurses having nothing but the best intentions for their patients at heart and as a result of this are willing to put up with these conditions in order to get their jobs done. This is commendable but unfortunately not how the system should work and it is also what results in errors being committed.

Currently, since nurses are the only line of defense against errors, they need to be taught more clinically relevant pharmacology. These nurses will then be able to pick up errors regardless of their experience level. This is of vital importance until such time as there are adequate numbers of ward of clinical pharmacists to look after in patients. There are clear problems with communication between the doctors and nurses and even between different teams of doctors. This has led to delays in patient therapy and often the nurses not knowing what to do for the patient. These communication problems must be addressed. One of the ways to improve communication between doctors and nurses is to have role play where they exchange roles for a short period of time. This can be done at university level, before they reach practice. Understanding the place of all the people in the MDT is of vital importance to ensure patient safety.

At a superficial level, the relationship between junior and senior doctors appears good, but based on the statements raised by the nurses it requires deeper investigation. The hierarchical structure that exists has merit, but it may prevent younger doctors from questioning problematic prescriptions or even asking about medicines that are unknown to them when they are forced to prescribe it.

All this feedback needs to filter down to the institutions and the medical schools. In the interim, simple measure can be implemented on a ward by ward basis until the entire hospital is covered. In this way, a large safety net can be drawn and the holes in Reason's (2000) cheese model can be closed and never line up.

7.2 Recommendations

In order to prevent and reduce errors, these recommendations should be taken into account by the hospital. The errors that have been seen, while not serious in terms of their health outcome, still have legal implications e.g. unsigned prescriptions or illegible prescriptions. There needs to be a hospital wide protocol on how to prescribe medicine and it should be taught to interns and medical officers on the day they start work at the hospital. Universities cannot teach specifics with regards to hospital prescribing and as Coombes *et al.,* (2008) points out, prescribing must be taught both at the university level but also at the work level. Perhaps having a mentorship programme could help. A doctor with experience could mentor younger doctors through their problems and also at the same time help deal with their problems and help them learn safe and effective prescribing. After all, the doctors who are now or will be coming into the hospital over the next two to three years, will not benefit from changes to their medical education even if it happens in the immediate future. Thus, there must be a system in place at the hospital level as well.

Additionally a new charting system needs to be introduced into the hospital and should be the type of a charting system that is used hospital wide or even a province wide and not vary from ward to ward or hospital to hospital. This charting system should take into account the needs of the prescribers and thus they should be included in the design stage for such an intervention.

A ward pharmacist seems to be a recommendation that along with the changing of the charts that the hospital could implement in a shorter period of time. The doctors and nurses in the focus groups were the ones who suggested the idea of having a pharmacist on the ward and were very open to the idea.

There is also a clear need for a change in the medical school curriculum with regards to an increase in the amount of clinical pharmacology teaching and learning. Whilst there has been a change in the way pharmacology was taught previously as the doctors in their focus group alluded to, there is not enough emphasis based on a core aspect of prescribing i.e. clinical pharmacology.

Ultimately a good method to prevent and reduce errors would be the use of a computerized system that enabled electronic prescribing on the wards. This solution as Coombes and colleagues in 2009 noted would produce a “hard” barrier to clinical mistakes and reduce the number of errors of illegibility and unsigned prescriptions as well as errors related to prescription writing. The hospital, however, does need to question whether or not this is a feasible alternative for them over redesigning the prescription charts.

7.3 Limitations

The lack of computerized records for patients limited the reliability of the data collection that could take place during the prescription collection phase of the study. As stated previously as well, some records of patients could not be found despite multiple search attempts as a result of that there is no way to know for sure if they would have influenced the data collection process in anyway.

In addition to that, our study was conducted in one hospital in the Johannesburg area, and as a result of that this information is not generalizable to other hospitals or even other provinces, nor can the data be generalized to give information regarding the state of prescribing errors in the entire hospital. This is ultimately the main limitation of this project and an area where further work is required.

Another limitation was the retrospective nature of our study, and as a result of this, it was impossible to correct any errors that may have taken place. This means that unlike other studies which looked at mean number of doses to intervention (e.g. Franklin *et al.,* 2011), this could not be done in this study.

Additionally, one cannot generalize the information that was obtained from the focus groups regarding systems errors and the causes of prescribing errors to another hospital. The findings, however, of these focus groups are representative of what is occurring in this hospital and the issues raised are of significant importance. These indicate areas for further research and direct interventions to reduce prescribing errors.

Another limitation of this process was the fact that since the name of the prescriber could not be recorded; the prescriber who had committed the errors could not be interviewed to understand what systems problems lead to the prescriber committing the error. This was how much of the data was collected by other authors regarding the causes of prescribing errors (e.g. Franklin *et al.,* 2011; Coombes *et al.,* 2008; Dean *et al.,* 2002a).

Furthermore the time from collection of prescription data to the time of the commencement of the focus groups was not close together and as result of that, it is possible that prescribers who committed such errors were not involved in the process of taking part of the focus groups, given that the focus groups were voluntary.

7.4 Further Studies

The natural next step is to expand this study hospital wide and to look at the prescribing and the types of prescribing errors that take place in the outpatient departments and compare these to the prescribing errors that were observed in the ward patients. By comparing these

one could thus have a better idea of what is happening with regards to prescribing errors in the entire hospital and not just in the wards alone. Furthermore, after the expanding such a study, the next logical study would be to compare the same kinds of wards to each other across different wards with the public sector in the Johannesburg area in the form of a multi-centre study to obtain an estimation of the percentage prescribing error for the area both among the adult population and the paediatric population. Equally, it would then be interesting to see what are the challenges that doctors and nurses face in these hospitals and as a result of that look at methods to reduce errors in those hospitals using a systems approach to error.

Another potential study could focus specifically at an intervention level where either pharmacists are placed on the wards or the prescription charts are redesigned or both. The investigator could look at the number of errors prior to placing this intervention in place and then see whether or not such interventions would produce a statistically significant difference between the number of errors after such interventions.

Another potential intervention study could track a set of young prescribers from the time they are at medical school, looking to improve their prescribing skills and compare them to others who have not undergone the same prescribing training as them and then look specifically at who makes less prescribing errors.

REFERENCES

Ajemigbitse AA, Omole MK, Osi-Ogbu OF, Erhun WO (2013). A qualitative study of causes of prescribing errors among junior medical doctors in a Nigeria in-patient setting. *Ann Afr Med*.;**12**(4):223-31.

Albarrak AI, Al Rashidi EA, Fatani RK, Al Ageel SI, Mohammed R (2014). Assessment of legibility and completeness of handwritten and electronic prescriptions. *Saudi Pharmaceutical Journal*. **22**:522-527

Aronson JK (2009). Medication errors: what they are, how they happen, and how to avoid them. *QJM*,**102**(8):513-21.

Avery AJ, Rodgers S, Franklin BD, Elliot RA, Howard R, Slight SP, Swanick G, Knox R, Gookey G, Barber N, Sheik A (2014). Research in practice: safe prescribing. *Br J Gen Prac*. **64**:259-261

Baker E, Roberts AP, Wilde K, Walton H, Suri S et al (2011). Development of a core drug list towards improving prescribing education and reducing errors in the UK, *Br. J. Clin. Pharmacol.*, **71**:2 / 190–198

Barber N, Rawlins M, Dean Franklin B (2003). Reducing prescribing error: competence, control, and culture, *Qual Saf Health Care* 2003;**12**(Suppl 1):i29–i32

Bergkvist A, Midlov P, Hoglund P, Larsson L, Eriksson T (2009). Amulti-intervention approach on drug therapy can lead to a more appropriate drug use in the elderly. LIMM-Landskrona Integrated Medicines Management. *J Eval Clin Pract*;*15*:660–7.

Bertels J, Almandaris AM, Cortoos PJ, et al (2013). Feedback on prescribing errors to junior doctors: exploring views, problems and preferred methods. *Int J Clin Pharm*;**35**(3):332–8. doi:10.1007/s11096-013-9759-y

Birmingham L, McLelland N, Bradley C (1999). The use of "as required" antimuscarinic medication for the treatment of antipsychotic induced side effects. *Br J Forensic Pract*; **1**: 11–5

Blum KV, Abel SR, Urbanski CJ, Pierce JM (1988). Medication error prevention by pharmacists. *Am J Hosp Pharm*;**45**(9):1902–1903.

Bobb A, Gleason K, Husch M, Feinglass J, Yarnold PR, Noskin GA (2004). The epidemiology of prescribing errors: the potential impact of computerized prescriber order entry. *Arch Intern Med*;**164**(7):785-92

Bowers A, Phillips P, Burnett F (2008). Reducing prescription errors on psychiatric inpatient wards; http://www.priory.com/psychiatry/prescribing_errors.htm (Last accessed 01 February 2016)

Braun V, Clarke V (2006). Using thematic analysis in psychology. *Qual Res Psychol* **3**: 77-101

Brits H, Botha A, Nicks L et al (2017). Illegible handwriting and other prescription errors on prescriptions at National District Hospital, Bloemfontein. *SAFPJ.* **59**(1):52–55

Calligaris L, Panzera A, Arnoldo L, Londero C et al (2009). Errors and omissions in hospital prescriptions: a survey of prescription writing in a hospital. *BMC Clin. Pharmacol*. **(9)**: 9-9

Condren M, Honey BL, Carter SM, Ngo N, Landsaw J, Bryant C, Gillaspy S (2014). Influence of a systems-based approach to prescribing errors in a pediatric resident clinic. *Acad Pediatr*;**14**(5):485-90.

Coombes ID, Stowasser DA, Coombes JA, Mitchell C(2008). Why do interns make prescribing errors? A qualitative study. *MJA*.**188**:89-94

Coombes ID, Stowasser DA, Reid C, Mitchell CA (2009). Impact of a standard medication chart on prescribing errors: a before-and-after audit. *Qual Saf Health Care*;**18**(6):478-85.

Dale A, Copeland R, Barton R (2003). Prescribing errors on medical wards and the impact of clinical pharmacists. *IJPP*; 1: 19–24

Dalmolin GRS, Rotta ET, Goldim JR (2013). Medication errors: classification of seriousness, type, and of medications involved in the reports from a University Teaching Hospital. *Braz J Pharm Sci*.;**49**(4):793–802.

Davey AL, Britland A, Naylor RJ (2008). Decreasing paediatric prescribing errors in a district general hospital. *Qual Saf Health Care*;**17**:146 – 9 .

Davis T (2011). Paediatric prescribing errors. *Arc Dis Child*; **96**:489–491. doi:10.1136/adc.2010.200295

Dearden E, Mellanby E, Cameron H, Harden J (2015). What technical skills do junior doctors require to prescribe safely? A systematic review. *Br J Clin Pharmacol.* **80**(6): 1303-1314

Dean B, Barber ND (1999).A validated, reliable method of scoring the severity of medication errors. *Am J Health Syst Pharm.***56**:57-62

Dean B, Barber N, Schachter M (2000). What is a prescribing error? *Qual Health Care*.**9**(4):232-7.

Dean B, Schachter M, Vincent C, Barber N (2002) Prescribing errors in hospital inpatients: their incidence and clinical significance, *Qual Saf Health Care*;**11**:340–344

Dean B, Schachter M, Vincent C, Barber N (2002a). Causes of prescribing errors in hospital inpatients: a prospective study.*Lancet*.**359**:1773-78

Dean B, Vincent C, Schachter M, Barber N (2005). The incidence of prescribing errors in hospital inpatients: an overview of the research methods. *Drug Saf.*;**28**:891–900.

Department of Health (1996). National Drug Policy for South Africa. Available from: http://apps.who.int/medicinedocs/documents/s17744en/s17744en.pdf Last Accessed: 27th March 2017

Devine EB, Wilson-Norton JL, Lawless NM, et al (2007). Characterization of prescribing errors in an internal medicine clinic. *Am J Health Syst Pharm*.;**64**:1062-1070.

De Vries TPGM, Henning RH, Hogerzeil HV, Fresle DA (1994). Guide to Good Prescribing - A Practical Manual. WHO. Available from: http://apps.who.int/medicinedocs/pdf/whozip23e/whozip23e.pdf Last Accessed: 06 February 2017

De Vos M, Graafmans W, Kooistra M, et al (2009). Using quality indicators to improve hospital care: a review of the literature. Int J Qual Health Care;21:119–29.

Duncan EM, Francis JJ, Johnston M, et al (2012). Learning curves, taking instructions, and patient safety: using a theoretical domains framework in an interview study to investigate prescribing errors among trainee doctors. *Implement Sci*; **7**: 86.

Dornan T, Ashcroft D, Heathfield H, et al (2009). An in Depth Investigation into Causes of Prescribing Errors by Foundation Trainees in Relation to their Medical Education. EQUIP Study. A Report to the General Medical Council, http://www.gmc-uk. org/FINAL_Report_prevalence_and_causes_of_prescribing_errors.pdf_28935150.pdf (accessed 30 January 2017)

Folli HL, Poole RL, Benitz WE, Russo JC (1987). Medication error prevention by clinical pharmacists in two children's hospitals. *Pediatrics*;**79**(5):718–722

Fontan JE, Maneglier V, Nguyen VX, Loirat C, Brion F (2003). Medication errors in hospitals: computerized unit dose drug dispensing system versus ward stock distribution system. *Pharm World Sci*;**25**(3):112-7.

Franklin BD, O'Grady K, Paschalides C, Utley M, Gallivan S, Jacklin A, Barber N (2007). Providing feedback to hospital doctors about prescribing errors: a pilot study. *Pharm World Sci*. **29**: 213-220

Franklin BD, Birch S, Savage I, Wong I, Woloshynowych M, Jacklin A, Barber N (2009). Methodological variability in detecting prescribing errors and consequences for the evaluation of interventions*. Pharmacoepidemiol Drug Saf*. **18**(11):992-9.

Franklin BD, McLeod M, Barber N (2010). Comment on 'Prevalence, Incidence and Nature of Prescribing Errors in Hospital Inpatients: A Systematic Review', *Drug Saf.*; **33**, 163-165, ISSN: 0114-5916

Franklin BD, Reynolds M, Shebl NA, Burnett S, Jacklin A(2011). Prescribing errors in hospital inpatients: a three-centre study of their prevalence, types and causes. *Postgrad Med J*.**87**(1033):739-45.

Ferner RE (2009). The epidemiology of medication errors: the methodological difficulties. *Br J Clin Pharmacol*. **67**(6).614-620

Garfield S, Reynolds M, Dermont L, Franklin BD (2013). Measuring the severity of prescribing errors: a systematic review. *Drug Saf*. **36 (12)**:1151-1157

Geffen J, Cameron A, Sorensen L, et al (2002). Pro re nata medication for psychoses: the knowledge and beliefs of doctors and nurses. *Aust N Z J Psychiatry*; **36**: 642–8

Gethins B (1996). Wise up to medication errors. Hospital *Pharmacy Practice*;**6**:323-8.

Ghaleb MA, Barber N, Dean Franklin B, Wong IC (2005). What constitutes a prescribing error in paediatrics? *Qual Saf Health Care*. Oct;**14**(5):352-7.

Ghaleb MA, Barber N, Franklin BD, Wong IC (2010). The incidence and nature of prescribing and medication administration errors in paediatric inpatients. *ArchDis Child*. **95**(2):113-8.

Gillespie U, Alassaad A, Henrohn D, Garmo H, Hammarlund-Udenaes M, Toss H et al (2009). A comprehensive pharmacist intervention to reduce morbidity in patients 80 years or older: a randomized controlled trial. Arch Intern Med;169:894–900

Gokhul A, Jeena PM, Gray A (2016). Iatrogenic medication errors in a paediatric intensive care unit in Durban, South Africa. *S Afr Med J*.;**106**(12):1222-1229.

Harrington M, Lelliott P, Paton C, et al (2002). The results of a multi-centre audit of the prescribing of antipsychotic drugs for in-patients in the United Kingdom. *Psychiatr Bull R Coll Psychiat*; **26**: 414–8

Hellstrom LM, Bondesson A, Hoglund P, Midlov P, Holmdahl L, Rickhag E et al (2011). Impact of the Lund Integrated Medicines Management (LIMM) model on medication appropriateness and drug-related hospital revisits. *Eur J Clin Pharmacol*;**67**:741–52.

Ho L, Brown GR, Millin B (1992). Characterization of errors detected during central order review. *Can J Hosp Pharm*. **45**(5):193-197

Horri J, Cransac A, Quantin C, Abrahamowicz M, Ferdynus C, Sgro C, Robillard PY, Iacobelli S, Gouyon JB (2014). Frequency of dosage prescribing medication errors associated with manual prescriptions for very preterm infants. *J Clin Pharm Ther*;**39**(6):637-41.

Hsieh H, Shannon SE (2005). Three approaches to content analysis. *Qual Health Res.* **15**(9): 1277-1288

Hysong SJ, Best RG, Pugh JA (2006). Audit and feedback and clinical practice guideline adherence: making feedback actionable. *Implement Sci*;**1**:9. doi:10.1186/1748-5908-1-9

Ivers N, Jamvedt G, Flottorp S et al (2012). Audit and Feedback: effects on professional practice and healthcare outcomes (Review). *Cochrane Database Sys Rev*. **(6)**. CD000259

Jamvedt G, Young JM, Kristofferson DT, et al (2006). Does telling people what they have been doing change what they do? A systematic review of the effects of audit and feedback. *Qual Saf Health Care*;**15**:433–6. doi:10.1136/qshc.2006.018549

Kaushal R, Bates DW, Landrigan C, McKenna KJ, Clapp MD, Federico F, Goldman DA (2001). Medication errors and adverse drug events in pediatric inpatients. *JAMA.* 25;**285**(16):2114-20.

Kidd L, Shand E, Beavis R, Taylor Z, Dunstan F, Tuthill D (2010). Prescribing competence of junior doctors: does it add up? *Arch Dis Child*.**95(3)**:219-21.

Keers RN, Williams SD, Vattakatuchery JJ et al (2014). Prevalence, nature and predictors of prescribing errors in mental health hospitals: a prospective multicentre study. . *BMJ Open*;**4**:e006084. doi:10.1136/bmjopen-2014-006084

Keers RN, Williams SD, Cooke J, Ashcroft DM (2015). Understanding the causes of intravenous medication administration errors in hospitals: a qualitative critical incident study. *BMJ Open*;**5**:e005948. doi:10.1136/bmjopen-2014-005948

Kennedy TJ, Regehr G, Baker GR, Lingard LA (2009). 'It's a cultural expectation...' The pressure on medical trainees to work independently in clinical practice. *Med Educ*;**43**(7):645-53.

Khalili H, Farsaei S, Rezaee H, Dashti-Khavidaki S (2011). Role of clinical pharmacists' intervention in detection and prevention of medication errors in a medical ward. *Int. J Clin Pharm.* **33:**281-284

Kohn LT, Corrigan GM, Donaldson MS (1999). To err is human: building a safer health system. Institute of medicine. Washington DC: National Academy Press. Page 18

Kopp, B. J., Erstad, B. L., Allen, M. E. et al (2006). Medication errors and adverse drug events in an intensive care unit: Direct observation approach for detection. Crit. Care Med.;**34**(2):415-425.

Leape LL, Bates DW, Cullen DJ et al (1995). Systems analysis of adverse drug events.ADE Prevention Study Group. *JAMA*;**274**(1):35-43.

Lederman RM, Parkes C (2005). Systems failure in hospitals - using Reason's model to predict problems in a prescribing information system. *J Med Syst*;**29**(1):33-43.

Lesar TS, Briceland LL, Delcoure K, Parmalee JC, Masta-Gornic V, Pohl H (1990). Medication prescribing errors in a teaching hospital. *JAMA*.;**263**(17):2329–2334.

Lesar TS, Lomaestro BM, Pohl H (1997). Medication-prescribing errors in a teaching hospital. A 9-year experience. *Arch Intern Med*;**157**(14):1569-76.

Levine S, Cohen M, Blanchard N, Frederico F, Magelli M, Lomax C, Greiner G, Poole R, Lee C, Lesko A (2001) Guidelines for preventing medication errors in pediatrics. *The Journal of Pediatric Pharmacology and Therapeutics.* **6**: 426-442.

Lewis P, Dornan T, Taylor D, Tully MP, Wass V, Aschcroft DM (2009). Systematic Review of the prevalence, incidence and nature of prescribing errors in hospital inpatients. *Drug Saf*.;**32**:379-89

Lewis PJ, Ashcroft DM, Dornan T, Taylor D, Wass V, Tully MP (2014). Exploring the causes of junior doctors' prescribing mistakes: a qualitative study. *Br J Clin Pharmacol*.;**78**(2):310-9.

Likic R, Maxwell SR (2009). Prevention of medication errors: teaching and training.*Br J Clin Pharmacol*.;**67**(6):656-61.

Long T, Johnson M (2000).Rigour, reliability and validity in qualitative research. *Clin Eff Nurs* **4**: 30-37

Lustig A (2000). Medication error prevention by pharmacists--an Israeli solution. *Pharm World Sci* ;**22**(1):21-5.

Makary MA, Daniel M (2016). Medical error-the third leading cause of death in the US.*BMJ*. **353**:i2139.

Malangu N, Nchabeleng SD (2012). Impact of prescribing and dispensing errors in patients on antiretroviral treatment in South Africa. *AJPP*.6(18):1337-1340

Maxwell S (2009). Medication errors: what they are, how they happen, and how to avoid them. *QJM.*102(8):513-21

Maxwell S (2010). Good prescribing: better systems and prescribers needed. *CMAJ*. **182**(6). 540-541

McDowell SE, Ferner HS, Ferner RE (2009). The pathophysiology of medication errors: how and where they arise. *Br J Clin Pharmacol.* **67**(6):605-13.

McPherson G, Thorne S (2006). Exploiting exceptions to enhance interpretive qualitative health research: insights from a study of cancer communication. *IJQM*. **5**(2): 1-11

Medicine and Related Substances Control Act 101 (1965). Available from: http://www.hpcsa.co.za/Uploads/editor/UserFiles/downloads/legislations/acts/medicines_and_related_sub_act_101_of_1965.pdf last accessed: 02 February 2017

Miller G, Franklin BD, Jacklin A (2011). Including pharmacists on consultant-led ward rounds: a prospective non-randomised controlled trial. *Clin Med*; **11** (4):312-316

Naidoo S (2017). Health crisis: Shortages are forcing junior doctors to run entire hospital units. *Sunday Times* Available from: http://www.timeslive.co.za/sundaytimes/stnews/2017/01/29/Health-crisis-Shortages-are-forcing-junior-doctors-to-run-entire-hospital-units Last Accessed: 07 February 2017

Nichols P, Copeland T-S, Craib IA, Hopkins P, Bruce DG (2008). Learning from error: identifying contributory causes of medication errors in an australian hospital. *Med J Aust*;**188 (5)**:276–9.

Ni KM, Siang CS, bin Ramli MN (2002). Noncompliance with prescription writing requirements and prescribing errors in an outpatient department. *Malaysian Journal of Pharmacy*. **1**(2):45-50

Notturno MA, Firestone JM, McElroy MW, Murray AJ (2003). Eliminating Medical Errors. AKMCI research center paper. Available from: http://www.macroinnovation.com/images/Eliminating_Medical_Errors.pdf Last accessed: 02 February 2017

Olaniyan JO, Ghaleb M, Dhillon S, Robinson P (2014). Safety of medication use in primary care. *Int J Pharm Pract*. **10**.1111

Otero P, Leyton A, Mariani G, Ceriani Cernadas JM (2008). Patient Safety Committee. Medication errors in pediatric inpatients: prevalence and results of a prevention program. *Pediatrics*.;**122**(3):e737-43

Page MA, Bajorek BV, Brien JE (2008). Prescribing in teaching hospitals: a qualitative study of social and cultural dynamics. *J Pharm Pract Res*; **38**: 286–92.

Paton C., Gill-Banham S. (2003) Prescribing errors in psychiatry. *Psychiatric Bulletin*, **27**: 208 -210.

Patterson ES, Cook RI, Woods DD et al (2004). Examining the complexity behind a medication error: Generic patterns in communication. IEEE Transactions on Systems Man and Cybernetics Part A-Systems and Humans;**34**(6):749-756.

Paul TR, Rahman AMd, Biswas M et al. (2015). Medication errors in a private hospital in Bangladesh. *Bangladesh pharm J*. **17**(1):32-37

Phansalkar S, Hoffman JM, Nebker JR, Hurdle JF (2007). Pharmacists versus non pharmacists in adverse drug event detection: A systemic review. *Am J Health Syst Pharm*. **64**(8):842-9

Pote S, Tiwari P, D'Cruz S (2007). Medication prescribing errors in a public teaching hospital in India: a prospective study. *Pharm Pract*;**5**(1):17-20.

Potts AL, Barr FE, Gregory DF, Wright L, Patel NR (2004). Computerized physician order entry and medication errors in a pediatric critical care unit. *Pediatrics*;**113**:59–63.

Procyshyn RM, Barr AM, Brickell T, Honer WG (2010). Medication errors in psychiatry: a comprehensive review. *CNS Drugs*;**24**(7):595-609.

Reason, J (2000). Human error: models and management. *British Medical Journal*; **320**:768-70

Ross S, Bond C, Rothnie H, Thomas S et al (2009). What is the scale of prescribing errors committed by junior doctors: a systematic review. *Br J Clin Pharmacol*. **67**:6 :629-640

Ross S, Loke YK (2009). Do educational interventions improve prescribing by medical students and junior doctors? A systematic review. *Br J Clin Pharmacol*.**67**:662-70

Ross S, Ryan C, Duncan EM, Francis JJ, et al (2013). Perceived causes of prescribing errors by junior doctors in hospital inpatients: a study from the PROTECT programme. *BMJ Qual Saf*.;**22**(2):97-102.

Ryan C, Ross S, Davey P et al (2014). Prevalence and Causes of Prescribing Errors: The PRescribing Outcomes for Trainee Doctors Engaged in Clinical Training (PROTECT) Study. *PLoS ONE*, **9**(1), e79802. http://doi.org/10.1371/journal.pone.0079802

Reynolds M, Jheeta S, Benn J et al (2016). Improving feedback on junior doctors' prescribing errors: mixed-methods evaluation of a quality improvement project. *BMJ Qual Saf* doi:**10**.1136/bmjqs-2015-004717

Rossiter D (ed) (2016). South African Medicines Formulary. 12th Edition. South African Medical Association Health and Publishing Group; Cape Town: South Africa

Seden K, Kirkham JJ, Kennedy T, Lloyd M, et al., (2013).Cross-sectional study of prescribing errors in patients admitted to nine hospitals across North West England. *BMJ Open.* **9**;3(1). pii: e002036. doi:10.1136/bmjopen-2012-002036.

Segal JB, Arevalo JB, Franke MF. Palazuelos D (2015). Recuing dosing errors and increasing clinical efficiency in Guatemala: first report of a novel mHealth medication dosing app in a developing country. *BMJ Innov;* **1:** 111-116

South African Pharmacy Council (2014). Board Notice 152 of 2014: Scopes of practice and qualifications for specialist pharmacists. *SAPC* Available from: http://www.gov.za/sites/www.gov.za/files/38327_bn152.pdf Last Accessed: 02 February 2017

Standing J, Khaki Z, Wong I (2005) Poor formulation information in published pediatric drug trials. *Pediatrics* **116**: e559-e562.

Stubbs J, Haw C, Taylor D(2006). Prescription errors in psychiatry - a multi-centre study. *J Psychopharmacol*. **20**(4):553-61.

Tully MP, Buchan IE (2009). Prescribing errors during hospital inpatient care: factors influencing identification by pharmacists. *Pharm World Sci*. **31**(6):682-8.

Tully MP, Ashcroft DM, Dornan T, Lewis PJ, Taylor D, Wass V (2009). The causes of and factors associated with prescribing errors in hospital inpatients: a systematic review. *Drug Saf.*;**32**(10):819-36.

Van der Veer SA, de Keizer N, Ravelli A, et al (2010). Improving quality of care. A systematic review on how medical registries provide information feedback to health care providers. *Int J Med Inform*:**79**:305–23. doi:10.1016/j.ijmedinf.2010.01.011

Velo GP, Minuz P. (2009)Medication errors: prescribing faults and prescription errors. *Br J Clin Pharmacol*. **67**(6):624-8.

Ward S, Wasson G (2016). Bridging the gap: improving safe prescribing from university to workplace. *Int J Clin Pharm*. **38**: 1023-1026

Winslow EH, Nester VA, Davidoff SK et al, (1997). Legibility and completeness of physicians'handwritten medication orders. *Heart Lung*. **26** (2), 158–164.

Wong ICK, Ghaleb M, Dean Franklin B, et al (2004). Incidence and nature of dosing errors in paediatric medications – a systematic review. *Drug Saf*;**27**:661–70.

Wong ICK. Wong LYL, Cranswick NE (2009), Minimising medication errors in children. *Arc Dis Child*; **94**:161-164

Zaidi S, Mordaunt C, Durnin N, Cooke S, Blackey JD (2015). Quantifying and reducing inhaler prescription errors in secondary care. *Int J Clin Pharm*. DOI 10.1007/S1106-015-0198-9

APPENDIX A- HUMAN RESEARCH ETHIC COMMITTEE CLEARANCE CERTIFICATE

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Mr Muhammed Vally

CLEARANCE CERTIFICATE	M110603
PROJECT	Prescription Error in the Charlotte Maxeke Johannesburg Academic Hospital
INVESTIGATORS	Mr Muhammed Vally.
DEPARTMENT	Department of Pharmacy & Pharmacology
DATE CONSIDERED	24/06/2011
M1106030DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 07/03/2012 **CHAIRPERSON** .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Mrs Shirra Moch

DECLARATION OF INVESTIGATOR(S)
To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**
PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

APPENDIX B- PRESCRIPTION ERROR CASE REPORT FORMS FOR ADULTS AND PAEDIATRIC PRESCRIPTIONS

Prescription Error- Case Report Form-Adult

Patient Code:_____ Date:_____ Age of Patient:_____ Clinical Diagnosis:_____

Ward Type:_____

Comment	Indications for use	Contra-indications for use	Special Precautions for use	Maximum Dose	Current Dose	Name of Drug

Comment	Indications for use	Contra-indications for use	Special Precautions for use	Maximum Dose	Current Dose	Name of Drug

Prescription Error Checklist for Adults adapted from Dean et al (2000)

Patient Code:_____ Date:_____ Age of Patient:_____ Clinical Diagnosis:_____

Ward:_____

No.	Scenario	Present	Absent	Comment
Errors in Decision Making				
Prescription Inappropriate for patient concerned				
1	Prescribing a drug for a patient for whom, as a result of a co-existing clinical condition, the drug is contra-indicated			
2	Prescription of a drug to which the patient has a documented clinically significant Allergy			
3	Not taking into account a potentially significant drug interaction			

4	Prescribing a drug in a dose that, according to the South African Medicines Formulary(SAMF), is inappropriate for the patients renal function			
5	Prescription of a drug in a dose below that recommended for a patients clinical condition			
6	Prescribing a drug with a narrow therapeutic index, in a dose predicted to give serum levels significantly above the desired therapeutic range.			
7	Writing a prescription for a drug with a narrow therapeutic range in a dose predicted to give serum levels significantly below the desired therapeutic range.			
8	Not altering a dose following steady			

	state levels significantly outside the therapeutic range			
9	Continuing a drug in the event of a clinically significant adverse reaction			
10	Prescribing two drugs for the same indication when only one drug is necessary			
11	Prescribing a drug for which there is no indication in the patient			
Pharmaceutical Issues				
12	Prescribing a drug to be given by intravenous infusion in a diluents that is incompatible with the drug prescribed			
13	Prescribing a drug to be infused via an intravenous peripheral line, in a concentration greater than that recommended for the peripheral			

	administration			
Errors in prescription writing				
Failure to communicate essential information				
14	Prescribing a dose or route that is not intended			
15	Writing illegibly			
16	Writing a drugs name using an abbreviation or other non-standard nomenclature			
17	Writing an ambiguous medication order			
18	Prescribing “one tablet” of a drug that is available in more than one strength of tablet			
19	Omission of the route of administration for a drug that can be given by more than one route			
20	Prescribing a drug to be given by intermittent intravenous infusion,			

	without specifying the duration over which it is to be infused			
21	Omission of the prescriber's signature			
Transcription errors				
22	On admission to hospital, unintentionally not prescribing a drug that the patient was taking prior to their admission			
23	Continuing a GP's prescribing error when writing a patients drug chart on admission to hospital			
24	Transcribing a medication order incorrectly when re-writing a patient's drug chart			
25	Writing "milligram" when "micrograms" was intended			
26	Writing a prescription for discharge medication that unintentionally deviates from the medication			

	prescribed on the inpatient chart			
27	On admission to hospital, writing a medication order that unintentionally deviates from the patient's pre-admission prescription			
Depending on a clinical situation the following may apply:				
28	Prescribing a drug in a dose above the maximum dose recommended in the SAMF or data sheet			
29	Misspelling a drug name			
30	Prescribing a dose regime (dose/frequency) that is not that recommended for the formulation prescribed			
31	Continuing a prescription for a longer duration than necessary			
32	Prescribing a drug that should be given at specific times in relation to meals without specifying this information on			

	the prescription			
33	Unintentionally not prescribing a drug for a clinical situation for which the medication is indicated			

Prescription Error- Case Report Form-Paediatrics

Patient Code:_____ Date:_____ Age of Patient:_____ Clinical Diagnosis:_____

Ward Type:_____ Weight (kg):_____

Comment	Indications for use	Contra-indications for use	Special Precautions for use	Maximum Dose	Current Dose	Name of Drug

Comment	Indications for use	Contra-indications for use	Special Precautions for use	Maximum Dose	Current Dose	Name of Drug

Prescription Error Checklist for Paediatrics adapted from Ghaleb et al (2005)

Patient Code: _____ Date:_____ Age of Patient: _____ Clinical Diagnosis:_____Weight (kg):_____

No	Scenario	Present	Absent	Comment
1	Prescribing a drug based on the weight of the patient and not writing the final dose calculated in the prescription sheet based on that weight.			
2	Writing illegibly.			
3	Prescribing a drug to a patient while the patient has a known allergy to that drug.			
4	Prescribing a drug to a child without documenting the weight of the child on the prescription sheet.			
5	Prescribing a drug to a patient without adjusting for renal insufficiency.			

6	Misspelling a drug name.			
7	Prescribing a dose regimen (dose/frequency) that is not that recommended for the formulation prescribed.			
8	Continuing a prescriptions for longer than necessary			
9	Unintentionally not prescribing a drug for a clinical condition for which medication is indicated			
10	Prescribing a drug that should be given at a specific time in relation to meals without specifying this information on the prescription			
11	Prescribing a drug given by intermittent intravenous infusion without specifying the duration over which the infusion must take			

	place			
12	Prescribing a drug with a narrow therapeutic index in a dose predicted to give serum levels above the desired therapeutic range			
13	Writing an ambiguous drug order			
14	Prescribing a drug given by intermittent intravenous infusion in a diluent that is incompatible with the drug that is prescribed.			
15	Writing a prescription for a drug with a narrow therapeutic index in a dose predicted to give serum levels below the therapeutic range.			
16	Omission of the prescribers signature			
17	Prescribing a drug without taking into account a potentially significant drug			

	interaction			
18	Continuing a drug in the event of a clinically significant adverse drug reaction			
19	Prescription of a drug in a potentially sub-therapeutic dose			
20	Writing a drugs name using abbreviations or non-standard nomenclature			
21	Prescribing a drug for a patient who has a specific contra-indication to its use			
22	Prescribing a drug to a patient without adjusting for body size			
23	Prescribing to a patient a dose that is not with the + or – 25% of the recommended dose			
24	Prescribing a dose that is calculated on an out of date body weight			

25	Prescribing a drug to a patient without adjusting for age			
26	Prescribing a drug to be taken when required, without specifying the maximum daily dose of the drug prescribed in the participant			
27	Not re-writing a prescription in full if a change has to be made to it (e.g. dosage increase or change in frequency)			

APPENDIX C- FOCUS GROUP INFORMATION SHEET AND INFORMED CONSENT FORM

Hello!

My name is Muhammed Vally and I am doing a Master's degree in Pharmacology at the University of the Witwatersrand. I am conducting a survey on the reasons for prescribing errors on the ward and I invite you to participate in this study. After reading this leaflet, please feel free to ask me any questions you may have.

All professionals make errors. Current theories of error management proscribe systems that should be put in place to prevent, identify or deal with the consequences of professional error. In medicine today, medication error is the most common type of medical error although interestingly, when quantified, prescribing errors in the United Kingdom have been found to be as low as 1.5 % (Dean et al, 2002). My research project aims to quantify errors made on prescribing sheets in the wards as well the possible causes for prescribing errors in the hospital system. Qualitative information eliciting the perceptions of staff involved in patient care is important in determining system error, thus **I am inviting you to participate in a focus group** of your colleagues, specifically to discuss the process of prescribing in the wards.

Your participation in this study is voluntary and you may refuse to take part or withdraw your consent at any time. If you choose not to participate, you will not be disadvantaged in any way.

- The study will be performed in a Johannesburg Academic Teaching Hospital (Parktown; South Africa).
- Two focus groups will be held, one for nurses and one for doctors. Participants from each ward will be invited attend and a minimum of two members for each of the aforementioned groups is required.
- The amount of time required for your participation in this study will be approximately 45 minutes
- You will then be asked a number of open-ended questions on your experiences and attitudes towards prescribing conditions on the ward.

  The group discussion will be voice recorded

- You may be requested to review the written transcripts of the focus group to confirm your contribution.
- Tapes will be kept in a locked cupboard for two years after publication or for 6 years if the data remains unpublished, thereafter it will be destroyed.

All information you give me will be kept strictly confidential by me. All participants will be given a study number and names will not be used in the transcripts and subsequent reports. All participants in the focus groups will be requested to behave in accordance with professional ethics and not divulge the identity of other participants in the group or the nature and content of the discussions. This study may be published in a journal but no one will know your individual answers.

There will be no cost to you to participate in this study. However, your participation could influence future prescribing systems in South African hospitals and may have implications for future prescribing education of medical students. Should you require any further information, feel free to contact me, Muhammed Vally on vallymuhammed24@gmail.com or 011 7172042 or my supervisor, Mrs Shirra Moch on shirra.moch@wits.ac.za or 011 7172372

Thank you for your participation.

INFORMED CONSENT FOR FOCUS GROUP PARTICIPATION:

I hereby confirm that I have been informed by the researcher, MUHAMMED VALLY about the nature, conduct, benefits and risks of the study entitled*:* PRESCRIBING ERROR IN AN ACADEMIC TEACHING HOSPITAL IN JOHANNESBURG

- I have also received, read and understood the above written information (Participant Information Leaflet and Informed Consent) regarding the study.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerized system by The Department of Pharmacology, University of the Witwatersrand.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.

- **I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.**

PARTICIPANT:

Printed Name Signature Date and Time

I, Muhammed Vally, herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

RESEARCHER:

Printed Name Signature Date and Time

INFORMED CONSENT FOR VOICE RECORDING IN THE FOCUS GROUPS:

I hereby confirm that I have been informed by the researcher, MUHAMMED VALLY about AUDIOTAPING the focus groups in the study: PRESCRIBING ERROR IN AN ACADEMIC TEACHING HOSPITAL IN JOHANNESBURG

- I am aware that my voice will be recorded during this study and I hereby grant the researcher permission to record my voice.
- I will also review transcripts of the audiotape (for veracity of transcription) if I so wish or at the request of the researcher.

PARTICIPANT:

Printed Name Signature Date and Time

I, Muhammed Vally, herewith confirm that the above participant has been fully informed about audio-taping the focus groups.

RESEARCHER:

Printed Name Signature Date and Time

*Dean B, Schachter M, Vincent C, Barber N (2002) Prescribing errors in hospital inpatients: their incidence and clinical significance, *Qual Saf Health Care*;**11**:340–344

*Dean B, Barber N, Schachter M (2000). What is a prescribing error? *Qual Health Care*.**9**(4):232-7.

APPENDIX D- FOCUS GROUP QUESTIONS

1. **Environmental Factors**

Main Question: Tell us about the work environment?

- Is there enough seating available for you when you are on duty but not busy
- Do you feel like your ward is understaffed?
- Which professionals do you feel are missing from your ward?
- How long is your average shift?
- Can you describe the hierarchy of the ward?
- Have you ever had to work a double shift? If yes, how many times on average?
- How do you feel when you get new staff on the wards?

2. **Team Function**

Main Question: Tell us about how the team functions on the ward?

- Do you find it easy to communicate with the other professionals on the ward?
- If no, what do you feel are the barriers to your communication?
- Do you find it easy to communicate with interns?
- If no, what do you feel are the barriers to you communication?
- Are written prescriptions and orders often incomplete?
- What do you if there is incomplete information?
- How often do you find conflicting information in a patients file?

3. **Ward Culture**

Main Question: Tell us about the culture of blame or lack thereof on your ward?

- Do you feel there is a culture of individual blame when something goes wrong on your ward?
- Are systems errors acknowledged when mistakes happen?
- Are you ever required to perform tasks outside your scope of practice?
- If you notice an error or a current or previous prescription, what do you do?
- Who takes responsibility for ensuring that written prescriptions are correct and fulfil all legal requirements?
- What do you if you cannot read a doctors handwriting?
- Who writes the most prescriptions on your ward? Interns, registrars, medical officers or consultants?

4. **Specific medicine related queries**

Main Question: Tell us about how you handle specific medicine related tasks?

- When you were in training,
    - did you learn the doses of drugs?

    - were you required to learn drug trade names or generic names?
    - do you feel learnt enough about the drugs?
    - were you taught anything about medication errors and the types of errors?
    - were you taught how to calculate drug doses?
    - do you feel you were given enough information to prescribe or administer drugs? If no, briefly explain what you felt was lacking?
- What do you do when you need to prescribe a drug but you not know the dose of the drug and you do not have an EDL/SAMF to look it up?
- How often have you calculated a drug dose for a patient?
- What do you use as a calculator to calculate these doses?

5. **Every day ward activities**

Main Question: Tell us about how you cope on the ward every day?

- Have you ever felt hungry during a shift but have been unable to get time to get something to eat?
- Have you ever felt forced to complete a task when you are tired or hungry?

6. **Patient cooperation**

Main Question: Tell us about how you deal with patients on the ward?

- How often do you find patients are unhelpful or uncooperative?
- When a patient says something to you, do you always understand what they are saying?
- What do you do if you do not understand them?
- Would you say most patients understand what you are saying to them?
- Do you feel that language is a barrier to your communication with your patients?