Medication Administration Errors Studied Through the Mixed-Methods Lens

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Declaration

I, *Hesham Abduldaeem*, confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

AE	Allergy Error
ANOVA	Analysis of Variance
BHFT	Berkshire Healthcare NHS Foundation Trust
CHWs	Community Hospital Wards
CWN	Community Ward Nurse
DD	Deteriorated Drug
DI	Drug Incorrect
EDs	Extra Doses
FE	Formulation Error
GzLM	Generalized Linear Model
HSE	Health and Safety Executive
ICU	Intensive Care Unit
IV	Intravenous
INR	International Normalised Ratio
LN	Lead Nurse
MAEs	Medication Administration Errors
MHRA	Medicines and Healthcare Products Regulatory Agency
MLE	Maximum Likelihood Estimation
NCCMERP	The National Coordinating Council for Medication Error Reporting and Prevention
NHS	National Health Service
NMC	Nursing and Midwifery Council
NCP	National Prescribing Centre
NPSA	National Patient Safety Agency
O	Omission
OE	Opportunity of Error
POD	Patient's Own Drug
PRM	Poisson Regression Model
PRN	From the Latin "pro re nata" meaning when necessary
PWs	Psychiatric Wards

PWN	Psychiatric Ward Nurse
RE	Route Error
SOP	Standard Operating Procedure
SPSS	Statistical Package for the Social Sciences
UD	Unprescribed Drug
UK	United Kingdom
USA	United States of America
WD	Wrong Dose
WTE	Wrong Time Error

Abstract

Background: In acute-care settings interruptions and workload increase medication administration errors (MAEs). However, MAEs are studied less within mental-health settings, where nursing staff specialise in psychiatric therapeutics and the mode of administration is different; e.g. in psychiatry, patients are not necessarily resting in hospital beds making bedside administration redundant. Existing research in psychiatry suggests MAEs are linked to morning rounds associated with more interruptions, medicines to administer, activities and staff shortages. An audit at the current Trust in 2014 found 13−52% of patients had at least one 'blank box' on their drug chart in the preceding seven days on seven mental-health wards necessitating further research. In addition, the Trust spans mental-health (psychiatric) and community wards (some with patient lockers for medication administration), providing an opportunity to examine differences across therapeutic areas and modes of administration.

Aim: The study aims to document the rate of MAEs across all inpatient wards at Berkshire Healthcare NHS Foundation Trust (BHFT) psychiatric and community hospital wards, and to investigate the interrelationship between error rates and a range of possible contributing factors as well as the causes behind the MAEs. The aim eventually is to produce recommendations for improving medication administration practices in this type of setting.

Methodology: This research used a mixed-method approach by adopting direct observation and semi-structured interviews to examine in depth the rate and causes of MAEs within mental-health and community hospital wards. The researcher visited all 19 wards (9 community hospital wards, 10 psychiatric wards) between July and October 2015 making 65 separate observations in total. Different modes of administration were noted alongside any interruptions and other potential contributing factors. The different modes of administration observed included administering at the patient 'bedside' *prepared in clinic room* (applied to psychiatric wards only), *using patient lockers* (applied to community hospital wards only) or a *drug trolley* (applied to community hospital wards only), or via a 'queue' where by patients were called to wait outside the clinic room (applied to psychiatric wards only) or a 'mixed' mode whereby medicines were given at the bedside or via a queue with the medication prepared in clinic room (applied to psychiatric wards only). In this research, data were entered into SPSS (v21) and analysed descriptively and using the Poisson Regression Model. These findings were discussed in structured interviews with nurses, pharmacists and compared with the researcher's own notes to describe the causes of errors using the organisational accident causation model as a theoretical framework, which were then triangulated with the quantitative findings.

Findings: In total 2237 opportunities for error were observed with 367 MAEs, resulting in a total error rate of 16.4%, 2.4% of which were wrong time errors. When the number of MAEs was separated to procedural errors versus clinical errors, the clinical error rate was 7.7%. The most frequent type of MAE was expiry errors (32% - a type of procedural error) followed by omissions (23% - a type of clinical error). Two modes of administration ('bedside-prepared in clinic room' and using 'bedside-patient locker') and the non-psychiatric drug group increased the risk of procedural errors. Two administration times (08:00 and 12:00 only), nurse grade (band-5 nurses) and two modes of administration (using 'bedside-patient locker' and 'mixed') increased the risk of clinical errors. Twelve interviews were completed with eight nurses and four pharmacists. The main active failure category for clinical errors was understood to be 'lapses', the main error-producing condition 'staff workload' and the main latent condition 'safety culture and priorities'. The main active failure category for procedural errors was judged to be 'situational violations' by the researcher but this was not the view of nurses and pharmacists who painted a more blameless picture of the workplace.

Conclusion: The findings show that expiry errors, a major component of procedural errors, take place across both psychiatric and community hospital ward types specifically when medication is given at the patient bedside and is prepared either in the clinic room or given via patient lockers, and that this is likely because of staff workload and/or lack of staff knowledge. The findings also suggest that omissions, a major component of clinical errors, were associated with the mixed mode of administration on psychiatric wards and the 12:00 administration time, and occurred because of a range of reasons that included workload, miscommunication and staff-related factors. Another type of clinical error was the wrong time error which was associated mainly with the patient lockers and the 08:00 administration time, mainly because of the high staff workload. The results suggest that patient lockers are not as safe as perceived because they are implicated in both clinical and procedural errors. In addition, the distinct contributing factors identified in this study can provide a means through which the occurrence of MAEs can be addressed. This mixed-method study makes a novel contribution to knowledge as the first study to compare mental-health and community hospital wards using the direct observation method, researching different modes of administration, and then comparing and contrasting the perceptions of the researcher with nurse and pharmacist opinions for causes of MAEs.

Chapter 1 Introduction

Medication administration errors (MAEs) on inpatient hospital wards are a known problem within healthcare. Although well-researched in the acute-care setting, the prevalence of medication administration errors is less well studied within mental-health settings, where nursing staff specialise in psychiatric therapeutics rather than physical health conditions. At Berkshire Healthcare NHS Foundation Trust (BHFT), ten psychiatric wards (PWs) provide five specialist psychiatric care; Adult mental-health, learning disability, older adult mental-health and intensive care units; the Trust also includes the Berkshire Adolescent Unit, which looks after younger patients. All psychiatric wards include mixed gender (male and female) patients that are located in separate rooms. The type of medication used in all mental-health wards is mostly psychotropic medications and antidepressants. Some of patients in adult psychiatric wards use other non-psychotropic medications for example, insulin, pain-killers etc. Most of the patients in older adults' wards usually have a lot of non-psychotropic medications besides their psychiatric medications. These medications are administered to patients through different modes of administration (queue mode, bedside-prepared in clinic room mode or mixed between queue mode and bedside-prepared in clinic room modes of administration). These modes of administration are detailed in full in Chapter 2 (Section 2.3.1) of this thesis. In addition, the Trust also includes nine community hospital wards (CHWs), which are used for 'rehabilitation' (occupational therapy, physiotherapy, needing mobility, chest rehab or elderly rehabilitation) in the transition of patients from acute-care settings before going back to their homes. In these wards, most of the patients were in different age groups, and had various medical problems.

The community hospital wards include both male and female patients located in separate rooms or in bays. Moreover, the type of medication used is mostly non-psychotropic medication except in the patients with dementia. The majority of the community hospital wards at BHFT provide a traditional medication administration service, involving nurses in selecting medicines for administration to patients from a general trolley. Some of the community wards provide a 'one-stop' service, which relies on using individually-labelled medicines stored in bedside-patient lockers; more description of medicines administration practices at BHFT is located in Chapter 2 (Section 2.3.1). Moreover, both psychiatric wards and community hospital wards at BHFT used paper drug charts that contain the patient medication which is screened by clinical pharmacists to ensure it is legally and clinically appropriate. Each psychiatric ward receives visits by a clinical pharmacist around 2-4 times weekly to review the medication and the pharmacist visits at least one ward round. Each community ward is visited by a clinical pharmacist three times weekly to review the medications, perform medicine reconciliations, and discuss therapy with patients and prescribers. The pharmacy medicines management technicians visit the wards once a week to complete a full top-up of stocks and non-stocks items. Table 1.1 shows more detailed description of the wards at BHFT.

Table 1.1: Detailed description of the wards at BHFT

Wards type	Wards	Wards speciality	Mode of administration	Bed numbers	Patients age range
Psychiatric Wards (PWs)	PW1	Younger mental-health	Bedside-prepared in clinic room	12	Between 12-17 years old
	PW2	Adult mental-health	Queue or mixed	26	Between 18-65 years old
	PW3	Learning disability	Bedside-prepared in clinic room	9	Between 18-65 years old
	PW4	Adult mental-health	Queue	23	Between 18-65 years old
	PW5	Learning disability	Bedside-prepared in clinic room	9	Between 18-65 years old
	PW6	Older adult mental-health	Bedside-prepared in clinic room or mixed	20	65 years old and over
	PW7	Adult mental-health	Queue	22	Between 18-65 years old
	PW8	Older adult mental-health (dementia)	Bedside-prepared in clinic room	20	65 years old and over
	PW9	Adult mental-health	Queue	27	Between 18-65 years old
	PW10	Intensive care unit	Bedside-prepared in clinic room	14	Between 18-65 years old
Community Hospital Wards (CHWs)	CHW1	Rehabilitation (occupational therapy, physiotherapy, needing mobility, chest rehab or elderly rehabilitation)	Bedside-patient locker	20	from 18 and older than 65 years old
	CHW2		Bedside-patient locker	12	
	CHW3		Bedside-trolley	30	
	CHW4		Bedside-patient lockers	12	
	CHW5		Bedside-trolley	24	
	CHW6		Bedside-trolley	29	
	CHW7		Bedside-trolley	22	
	CHW8		Bedside-patient lockers	12	
	CHW9		Bedside-patient lockers	28	

It is not known whether the type and frequency of medication administration errors differ across the different care settings at the Trust, nor indeed whether such errors mimic national and international averages determined in published studies.

An audit of 'blank boxes' (where the drug chart is not signed to indicate dose given, detailed later in this thesis) completed by the pharmacy department at BHFT in 2014 across seven mental-health wards and seven community hospital wards at the Trust retrospectively, examined all in-patient drug charts over a 7-day period to determine the number of medication administration records. 13-52% of patients had at least one blank box, and there appeared to be a higher percentage of patient charts with blank boxes in the mental-health wards compared to the community wards, as might be anticipated due to the fact that patients on mental-health wards are not bed-bound, may be more likely to refuse their medication and could reasonably be expected to be off the ward. However, the audit did not set out to use detailed inferential statistics for making any such comparisons. What the audit and subsequent improvement work did instead was to show that targeted interventions on one ward led to a reduction in the number of blank boxes, with a recommendation that this should be spread to other inpatient areas.

The Trust has a Standard Operating Procedure (SOP) for 'Administration of medicines' as well as one for 'Omitted, refused or wasted medicines'. Before the current study, the extent and nature of the range of MAEs across the wards at the Trust were not known, nor the range of reasons for errors, including omissions and blank boxes.

This study examines firstly the rates and types of MAEs, including omissions and blank boxes, on all wards at the Trust using the direct observation method. One of the objectives of the study is to record all potential contributing factors as well as the apparent reason for any MAEs including omissions and blank boxes observed to take

place. In addition, relevant healthcare staff were interviewed in order to gain a more in-depth understanding about the perceived reasons for MAEs, and the other deviations from practice guidelines including omissions and blank boxes. The ultimate objective of this thesis is to make evidence-based recommendations for improving medication administration practices at the Trust and in other similar settings.

This thesis describes a mixed-method study that examined in depth the rate and causes of MAEs within a mental-health and community hospital Trust. The ward settings were vastly different in that some used a standard trolley system, some a queuing method and some a patient locker system. This introduction chapter therefore focuses on introducing the concept of MAEs within a healthcare domain, the difference between the modes of medication administration rounds, the different research methodologies that have been adopted for recording MAEs, the rates of MAEs reported in the literature, type of MAEs, the potential for harm from MAEs, contributing factors and causes linked to MAEs and suggested interventions to reduce MAEs.

1.1 Medication safety in hospital settings

Safety in healthcare settings including medication safety is considered an important and under-researched area around the world and the UK in particular. The NHS Department of Health (2000) set up a comprehensive programme ‘An Organisation with a Memory’ to learn from incidents and service failures and more effectively from adverse events and near misses. The aim was to reduce the risk of failures such as medication errors as well as to provide recommendations that could be taken to help ensure that similar events can be avoided in the future (Donaldson, 2002).

In addition, ‘To Err is Human’ is a report produced by the quality of healthcare in an American project. The report lays out an inclusive strategy to address serious healthcare

problems and to point out a list of recommendations for safe medication practices and to improve awareness of the problem by the health professionals (Donaldson et al., 2000). Studying MAEs is part of a more global approach towards safer medicines management processes. One of the key documents published in relation to medicines safety in the UK highlighted that the most serious incidents were caused by errors in medicines administration (NPSA, 2007). Prior to that, the Audit Commission's (2001) report "A Spoonful of Sugar – Medicines Management in NHS Hospitals" had emphasised ways in which processes relating to medicines could be optimised in secondary care exactly to prevent such issues. It is important to briefly examine where medication errors can occur within the medication flow system.

As shown in Figure 1.1 the first step in the medication flow procedure is the prescribing of the drug, followed by its dispensing, then administration and finally the monitoring of its effects and side-effects. Accordingly, medication errors can occur at any of these stages. Therefore, medication errors can be conceptualised in terms of the stage at which they occur (Franklin, 2010).

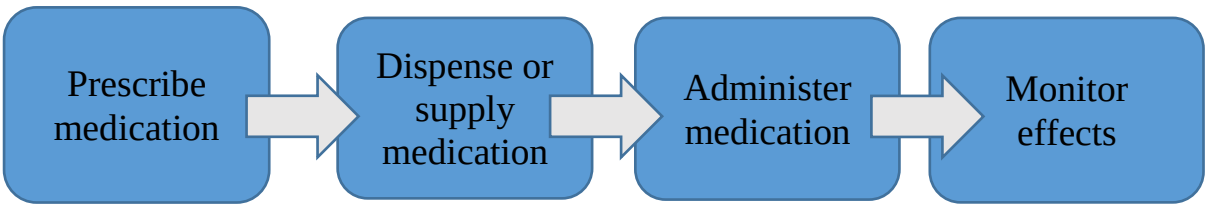

Figure 1.1: A simplistic classification of the medication flow stages where a medication error could take place at each of these stages (adapted from Franklin, 2010)

For completeness, according to the Medicines and Healthcare Products Regulatory Agency (MHRA), a medicinal product is defined as:

> *"Any substance or combination of substances presented as having properties for treating or preventing disease in human beings. Any substance or combination of substances which may be used in, or administered to, human beings, either with a view*

> *to restoring, correcting or modifying physiological functions by exerting a pharmacological, immunological or metabolic action, or to making a medical diagnosis"* (MHRA, 2016).

There is a whole range of products that might be prescribed and then administered to patients during a medication administration round. This point becomes important later in this thesis when examining the different types of products that were observed to be administered to patients during ward rounds at the hospital Trust that was the research base for this work.

Certainly, physicians, pharmacists, technicians, nurses and even patients could all be involved in making medication-related mistakes (Clark, 2004). The medication administration step is associated with a significant proportion of all identified errors overall; for example, 44% of medication errors are thought to relate to MAEs (Leape et al., 1995). Maidment et al. (2008) found that MAEs in older patient psychiatric wards had the highest rate compared to other medication errors. To explain further, MAEs are defined as "any dose of medication administered (or omitted) that deviated from the written medication order" (Allan and Barker, 1990). Using this definition, omitting or delaying to give or take a drug is also considered as a type of MAE (Franklin, 2010). A National Patient Safety Agency (NPSA) (2010) report indicated that 27 deaths, 68 severe harms and nearly 21,000 other patient safety incidents were associated with omissions or delays in medicine administrations in the three years of data analysed. It can be seen therefore that MAEs including omissions or delays in medication administration are not inconsequential making them worthy of further research.

As well as missed and delayed doses, MAEs can include administering the wrong drug or dose which can of course also have serious consequences for patients. According to the NPSA, the most commonly reported type of MAE involves the wrong dose being

administered, for example the incorrect strength being given or at the wrong frequency (NPSA, 2007). In formal secondary-care settings, MAEs relate in the main to the activities carried out by ward nurses. In fact, one of the main duties of nurses in hospitals is to take responsibility for selecting and administering medicines to patients during medication rounds or at other intervals (Greengold et al., 2003).

The traditional ward round involves nurses administering medicines to patients at regular times using a drug trolley and against a paper or electronic prescription. Medicine administration can take about 30–50% of nurses' time in hospitals and it is considered one of the tasks most associated with risk in terms of nurses' overall duties (Pepper, 1995, Armitage and Knapman, 2003). The next section provides an overview of the traditional as well as other modes of drug administration on wards relevant to the current study.

1.2 Different modes of drug administration on wards

Before examining different ways in which medication administration rounds take place on hospital wards, it is worth explaining some key activities underpinning the administration process. The prescribing process is normally initiated on a hospital ward when doctors write on a paper or electronic drug chart. The paper drug chart is the more traditional means for prescribing medication, and it is important to clarify that the hospital Trust which is the focus of the current study used only paper drug charts. Hence, the electronic prescribing process is covered in this thesis in reference to other studies, and is itself not the subject of the current work. The paper drug chart then contains the set of instructions that nurses follow when completing a medication administration round. As well as being signed to authorise nurses' work, where there is a ward pharmacy service, the drug chart is also screened by clinical pharmacists to

ensure it is legally and clinically appropriate. The specific setting of the wards and the medication administration processes at the hospital Trust where this work was completed are covered in much more detail in subsequent chapters.

The other system underpinning the medication administration process in general is the supply and maintenance of medication to the ward. This system is in the main the responsibility of the pharmacy department within most UK hospitals. For example, where the service exists, a designated pharmacy technician will visit the ward on a regular basis to maintain stocks and non-stock items for individual patients via a pharmacy distribution service. Briefly, this 'top-up' visit to the ward is to record the level of stock items on a minimum stock list and non-stock items on a pharmacy non-stock drug request sheet so that items can be replenished as needed- i.e. the aim is to monitor the stock level and then re-order if necessary. Once the pharmacy department receives this list or sheet the suitable supply will be accordingly dispensed and sent up/across to the ward.

Items sent up to the ward thus enable reloading of stock and non-stock items into appropriate storage spaces upon receipt via a distribution box. On the ward, medication is stored securely in stock cupboards, drug refrigerators, the drug trolley or bedside-patient lockers, which are the storage spaces on wards, and the master key for these storage spaces is kept by the ward nurse in charge (NHS Professionals, 2010). The availability of prescribed medication items at ward level underpins the medication administration process, whereby nurses select and administer prescribed medication at scheduled times to patients.

In most UK hospital wards, medication administration rounds are scheduled to take place four times a day. This is to cater for most dosage schedules of drugs – for

example, some drugs are prescribed for once daily administration whereas others can be given four times a day. Normally either one or two nurses take charge of the medication administration round. There are different modes for drug administration, and these are described below in more detail, but regardless of these differences, where a paper drug chart is used, the round begins usually with the nurse examining the drug chart for each patient in turn. The drug chart is thus picked up by a nurse and each medication order scanned in order to establish whether a dose is due for the patient on that round.

The medication due is then selected from the appropriate storage environment (stock cupboards, drug refrigerators, drug trolley or bedside-patient locker) before being given to the patient. Official guidelines do exist for nurses undertaking medication administration on hospital wards as shown in Table 1.2. In the UK, a range of medication administration processes exist, each focusing on a specific medication storage environment. Although, according to Jevon et al. (2010, p. 104) medication can be administered from a drug trolley, the bedside-patient locker and the stock cupboard and this very much depends on what the overall process is. For example, with one-stop dispensing schemes where patients' own drugs (PODs) are used, the main storage environment for the medication becomes the patient's bedside locker. In contrast, with a traditional ward round that uses a drug trolley, medication can be obtained from the drug trolley, the stock cupboard and the bedside locker if this exists. The hospital Trust which was the base for this research included 19 different wards that used a range of medication storage environments as described below from which medication could be selected during the administration round.

Table 1.2: Recommend guidelines for nurses during the medication administration round (adapted from NMC, 2015)

Medication administration guidelines
• ***Check the identity of the patient and be sure to give the right medicine to the right patient***
• ***Check that the patient is not allergic to the medicine before administering it***
• ***Know the therapeutic uses of the medicine to be administered (normal dosage, side effects, precautions and contra-indications)***
• ***Be aware of the patient's plan of care***
• ***Check that the prescription or the label on medicine dispensed is clearly written and unambiguous***
• ***Check the expiry date***
• ***Considered the dosage, weight where appropriate, method of administration, route and timing***
• ***Administer or withhold medication in the context of the patient's condition***
• ***Contact the prescriber or another authorised prescriber without delay where contra-indications to the prescribed medicine are discovered***
• ***Make a clear, accurate and immediate record of all medicine administered, intentionally withheld or refused by the patient, ensuring the signature is clear and legible***

1.2.1 Medication administration from a drug trolley

The drug trolley is a wheeled, contained trolley that remains on the ward and is lockable. On the inside, this is normally divided into several internal shelves, including shelving on the inside of the door where appropriate. A drug trolley is also normally fitted with a push handle and a heavy-duty lock that allows it to be always locked to the wall unless being used for the medication administration round. The stock items and big

bottles of liquid medication were observed to be stored in the door shelving in the drug trolleys in this study. Moreover, other shelves included named-patient medications where each patient's medication was placed together in one container organised by their name and each container itself was labelled with the patient's information e.g. name, NHS number, date of birth, etc. It is important to highlight that most UK general hospital wards use a drug trolley as part of (if not the main) the mode of administration (McLeod et al., 2014), and this is considered to be the traditional way of medication administration. During the medication administration round, the nurse releases and unlocks the drug trolley from the wall and moves the trolley from bedside to bedside as part of the work process.

The drug administration round normally starts from one end of the ward and continues in sequence focusing on one patient at a time and ends with the last patient on the ward. In some cases, where the ward is large, the round might be split into two with two trolleys being used at the same time. For example, here is an illustration of one ward which has 28 beds. The beds are arranged in this order: beds A1–A6 (in 'A bay'), B1–B6 (in 'B bay'), C, D (side rooms), E1–E6 (in 'E bay'), F1–F6 (in the 'F bay'), and G, H (side rooms). 'A' and 'B bay' were male-only and 'E' and 'F bay' were female-only. The side rooms were used for isolated patients. In this case, two half drug rounds took place at the same time, to serve each of two sides of the ward (bays A-B with C, D side rooms and bays E-F with G, H side rooms) and two drug trolleys existed for this purpose, enabling simultaneous drug administration on the ward by two different nurses.

1.2.2 Medication administration from a bedside locker

The bedside locker is a wooden or metal locker locked by a key and positioned on the wall beside a patient's bed. This bedside locker can be divided into two shelves and is designed to keep the patient's medication safe, secure, and close to their bed. The locker includes only that patient's medication supply as written on their drug chart. This medication supply could be dispensed directly from the pharmacy department or from POD – i.e. where patients admitted to the hospital ward bring their medications with them and this is allowed to be used on the ward.

The Nursing and Midwifery College (NMC) (2015) has indicated that nurse registrants may use patients' own medicines in accordance with hospital guidance. Also, the nurse registrant is required to take responsibility to check the POD. First, their suitability should be checked and whether they are prescribed for the patient, and if they meet criteria for use. Second, nurses must explain to the patient how and why medication could or could not be used. Finally, the approved POD should be labelled and kept safe in a bedside locker. At the hospital where this research was based, pharmacy staff were predominantly responsible for checking patient's POD.

Medication administration from a bedside locker has been used in some UK general hospital wards and is not a new concept. During the medication administration round the nurse administers the medication to the patient from their locker after checking against the drug chart. The medication administration process here is almost similar to the process using a drug trolley explained above, where the round starts in sequence from one end of the ward focusing on one patient and ends with the last patient on the ward; the only difference is that the medications are administered from the bedside locker instead of the drug trolley. As well as medication administration from a bedside

locker, occasionally the nurse can use the drug trolley to administer stock items. For example, this occurs when some medication is not available in the patient locker (e.g. has been prescribed since admission) or large bottles of medication that cannot fit into the locker.

On wards that used the bedside locker at the Trust there were two types of rooms. There were single-bed rooms and also multi-bed rooms which were divided into bays and beds as mentioned previously. Also, when the ward was large, the two half drug rounds took place at the same time with one nurse in charge of each half.

Some UK hospital wards using this mode of administration (i.e. patient lockers) do this as part of a one-stop dispensing system which is "combining inpatient and discharge dispensing medication into a single 28-day supply, labelled for discharge". This means that when a patient is discharged, the medication should be ready for discharge meaning that no item need to be dispensed and speeding up the discharge process (Hospital Pharmacist Group, 2002).

Moreover, the National Prescribing Centre (NPC) (2007, 2008), indicates that an important element of one-stop dispensing is the use of individual lockers where all of one patient's medicines are stored during their hospital stay; patients can either use their own medicines brought from home, or receive a month's supply from the pharmacy.

1.2.3 Medication administration from the clinic room

Another mode of medication administration, which is perhaps unique to the mental-health setting, is administration from the clinic room. Here, each ward has a stock cupboard for storage of regular items as well as larger products. The stock cupboard is usually located in each ward in the clinic room. In other wards where the drug trolley is used as the main mode of drug administration, the stock cupboard acts merely to hold

items for restocking of the trolley; when a stock item is not found in the drug trolley or the bedside locker during a medication administration round, the nurse administering for that round can obtain the item from the stock cupboard if it is located there. But in specific settings medication administration can take place straight from the stock cupboard or a locked drug trolley which stays within the clinic room. This was particularly applicable for the mental-health (psychiatric) wards within the hospital setting of the current study.

When medication was administered from the clinical room, the nurse responsible for the medication administration round firstly checked all of the drug charts on the ward. This was in order to identify who is due medication during that particular round. Once identified, these patients were called to wait outside the clinic room in order that their medication is prepared and given to them. This mode of administration is sometimes seen to involve 'queuing' which is another given name to describe the process. Anecdotally the nurses involved in the current study described this mode as helping them control and regulate the process of medication administration.

1.3 Medication administration errors

This section focuses on formally defining an MAE, methods used to determine MAEs, reporting on rates as well different types of MAEs, potential for harm from MAEs, contributing factors that might increase the MAE rate and studies which suggest ideas to decrease the occurrence of MAEs.

1.3.1 Definition of MAEs

Even before focusing on defining MAEs it is worth highlighting that there are many definitions found in the literature for the broader term 'medication errors', meaning that there is no consensus view about this topic. For example, the National Coordinating

Council for Medication Error and Prevention defined a medication error as "any preventable event that may cause or lead to inappropriate medication use or patient harm, while the medication is in the control of the health care professional, patient, or consumer" (NCCMERP, 2016). In a similar vein, Williams (2007), defined medication errors as "a miscalculation in the prescriptions, supplying, or administration of a drug". The NPSA (2007) definition is broader and refers to the medication flow process "medication errors are any incident where there has been an error in the process of prescribing, dispensing, preparing, administering, monitoring or providing medicines advice, regardless of whether any harm occurred or was possible". As already alluded to above, MAEs make up a substantial part of all medication errors.

An MAE has been defined in different ways too. For example it has been defined as: "any dose of medication administered (or omitted) that deviated from the written medication order" (Allan and Barker, 1990). Similarly, Barker et al. (2002b), defined the MAEs as: a ''deviation from a prescriber's valid prescription or the hospital's policy in relation to drug administration, including failure to correctly record the administration of a medication". The definition used in this thesis is "any dose of medication administered (or omitted) that deviated from the written medication order" (Allan and Barker, 1990) which is most relevant to this research study and has been used in a number of MAE studies (Keers et al., 2013b).

MAEs have been studied extensively in the UK. According to Dean (1999), the first published study on MAEs was in the UK in mid-1960s, where the administration system was different than is used nowadays. There was no drug chart to record medication administered to the patient and there were only the nurses' notes. Then the administration system was developed step by step according to a recommendation in

1958 that medication should be administered from an original drug order. Additionally, the study published by Hill and Wigmore (1967 as cited by Dean, 1999) at the London Hospital was the first MAEs study published in the UK based on the observational method.

This section provides a concise review of articles published on the rate of medication administration errors in different hospital wards in the UK and elsewhere using the direct observation method (and a brief look at other methods used to measure MAEs). The reviews will also highlight the studies that include the link between contributing factors and MAEs as well as the causes behind the MAEs.

1.3.2 Methods used to determine MAEs

Internationally MAEs have been measured in a variety of hospital wards. Some of the published studies measure the type, frequency and rate of MAEs, the harm that could arise from errors found and the contributing factors as well as the causes behind the MAEs. There are different methods used to detect MAEs such as chart review, incident report and observation. According to Massetti (2011) the technique measuring medication errors have various strengths and weaknesses. The study showed that direct observation have a higher chance of detecting drug relating problem than both the chart reviews and the incident reports. The direct observation method is seen as a gold standard and is the method that was adopted in this study. But before explaining how the direct observation method determines MAEs in more detail and what the literature shows, it is important to briefly explain the other ways e.g. chart review and incident report in which MAEs are studied on hospital wards (see Figure 1.2).

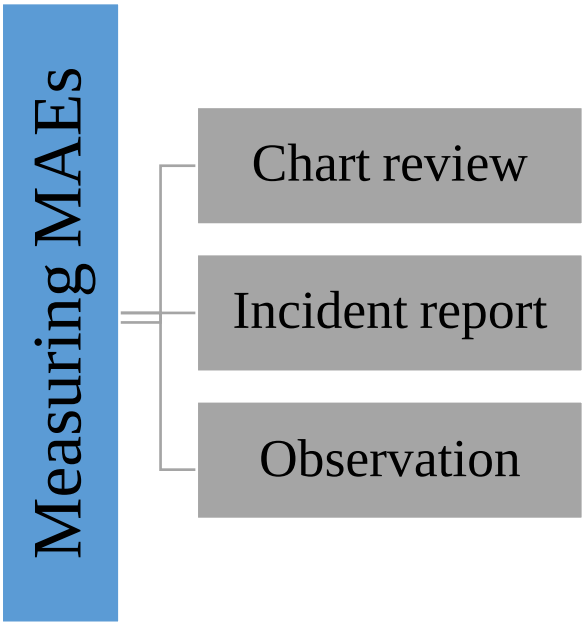

Figure 1.2: Visual representation of methods used to determine MAEs

1.3.2.1 The retrospective chart review

Chart review is when the researcher detects the MAEs directly from the patient's drug chart after the medication was given in a specific period of time. This method has both positive and negative qualities. One of the positives is that it does not take a long time to complete a study using this method and there is potential for repeatability in that the chart can be reviewed again by another researcher; however, not all of the types of MAEs can be detected using this method. For example, only omissions can be detected using this method and no other types of MAEs (Grasso et al., 2003, Haw et al., 2007).

1.3.2.2 The prospective or retrospective incident report

Another method is self-report where a healthcare practitioner detects then reports any errors by him/herself, but this method is not commonly used according to some studies. The incident report which includes self-reporting is a system implemented in most hospitals. As it is already in place to detect and report any medication error by a staff or patients, the researcher could feasibly collect the data from the incident report for the purposes of analysis.

However, this is not viewed to be a very efficient method because the majority of errors, even if detected, are thought not to be reported (Ito and Yamazumi, 2003, Balas et al., 2004, Haw et al., 2005, Maidment and Thorn, 2005, Balas et al., 2006, Haw and Cahill, 2011). The reason that some participants might not report the incidents in psychiatric ward according to Haw et al. (2014) study is the pressured nature of the job and the lack of available time to report each incident. For example, some nurses noted that reporting incidents was not worthwhile to complete a form which on average will take 10–15 minutes and reporting it was too much work. Moreover, some nurses said that they would not report the errors because of a lack of knowledge about whether it was an error or how to report it, or they were afraid of the consequences of reporting these incidents. Another reason by Lee (2017) for not reporting errors in general wards was fear of the possible negative impact and action that might follow from reporting the error.

1.3.2.3 The direct observation method

One of the most common methods adopted to measure MAEs is the direct observation method. It is worth clarifying that, as Coolican (2014, p. 138) highlighted, observational methods generally carry different meanings in research. It can refer to the technique of making observations within an experimental design in order to measure a dependent variable. Also, it is quite common in qualitative studies where 'participant observation' takes place and can be accompanied by interviews and examination of notes relating to an organisation (Coolican, 2014, p. 137). Moreover, the observational method is a "way of gathering data by watching behaviour, events, or noting physical characteristics in their natural setting" (Taylor-Powell and Steele, 1996).

Using observation as a method to measure MAE is where the researcher observes the drug administration round by shadowing the nurses to detect the MAEs and makes

notes discretely using a data collection form (Dean and Barber, 2001). The data collection form can capture data including the type of error for each drug administration round observed. More detail about this method is provided in Chapter 2 of this thesis. For now, as Barker et al. (2002b) state, direct observation methods that capture MAEs are considered to be the most reliable data collection method.

1.3.3 The rate of MAEs reported in the literature

Studies have used different measurement methods to detect MAEs including chart reviews, incident reports and direct observation. Also, different denominators have been used to calculate the error rate such as the total number of prescriptions written (the total opportunity of error OE), the number of medications written per patient, and the denominator might be a separate time period such as one month or an identical time period e.g. patient-days (Procyshyn et al, 2010). Moreover, numerous studies measuring MAEs have been carried out in the UK, USA and some other countries, and most of these studies are based on the observational method, considered to be a gold standard, and adopted in the current study. One aim of this section is to report on the MAE rates found in UK studies using the observational method but it is worth briefly touching on studies using other methods to detect and measure MAEs to outline the weaknesses of these methods (see Table 1.3). The next few paragraphs illustrate the way in which different methodologies used to detect MAEs results in vastly different rates of MAEs being reported and how the non-standardised way in which MAEs are reported makes it almost impossible to make comparisons or derive a universal MAE rate. After that, when the focus returns to measuring MAEs using the observational method, it becomes apparent that even using this method and using similar reporting units does not return comparable MAE rates.

First then, one of the methods used to detect MAEs is the chart review. An example is a study by Grasso et al. (2003), based in a psychiatric hospital in the USA. This study used retrospective chart reviews to detect MAEs for 31 randomly selected patients and compared the data with incident reports (self-report) during 1st June to 15th Oct 2001. The study found a higher MAE rate of 6.8% (1443 / 21,033) from chart reviews compared with only 9 incident reports. Clearly, the MAE rate found using the chart review was higher than could be detected using the incident report in that study. This therefore shows the chart review to be better than incident reports at detecting MAEs.

Another relevant study is by Haw et al. (2007), at two elderly long-stay wards in an independent psychiatric hospital. The study provides a comparison of MAE rate from three different methods, (1) direct observation of administration rounds, (2) medication chart review and (3) incident reports, over a 3-month period. The results yielded 369 medication administration errors from 1423 items observed which gives a 25.9% MAE rate for the observational method. This is compared with only 148 errors detected from the chart review and zero error from the incident reports. While both the Grasso et al. (2003) and Haw et al. (2007) studies illustrated that chart reviews detect more errors than incident reports, still the Haw et al. (2007) study illustrates that the observational method detected even a higher MAE rate compared to chart reviews.

This is backed up by a study by Flynn et al. (2002), comparing the method used to detect medication errors rate around 36 hospitals in the USA, which found that the observational method showed an 11.7% error rate comparing to a 0.7% error rate from chart reviews and a 0.04% error rate from incident reports. They also found that the error rate based on the observational method was more accurate than rates based on other methods. Another study that has used the direct observation method with chart

reviews to detect MAEs was by Agalu et al. (2012), located at the intensive care unit (ICU) at the University Specialised Hospital, Ethiopia. However, although the study showed a very high MAE rate of 51.8%, it combined the results from both the observation and chart review methods and therefore did not clarify whether the chart review was inferior to the observational method, or not, at detecting errors.

There are also researchers that have detected MAEs by examining incident reports alone, either prospectively or retrospectively. The incident reports systems according to Vincent (2006, p. 82), are standard systems that have basic clinical information and a brief description of the incident. Two similar studies using prospective incident reports (self-report) over 28-days are reported here. The first study by Balas et al. (2004), was located in different hospital wards (medical/surgical and in intensive care units) in the USA. This study showed that of the different incident reports, the MAE was 58% of (199) total errors reported. The other study was also by Balas et al. (2006), and took place at several hospital critical care units in the USA. This study which also measured different errors using incident reports found the MAE was 56.7% from the total incident reports (224) found. Therefore it seems that when incidents are reported, a large proportion of errors appear to be related to MAEs. Of course studies such as these do not give any indication of what the incidence of MAEs are as compared to all doses given or the total opportunities for error. This means that although incident reporting is useful as an indicator of the frequency with which MAEs are reported compared to other errors, the method provides no information about MAE rates, because of the absence of a denominator.

There are other studies using prospective incident report methods to identify MAEs in mental-health wards over a long duration of time which attempt to give an indication of

the rate. A study by Ito and Yamazumi (2003), for example, examined incident reports in long-stay wards based in 44 private psychiatric hospitals for a 2-month period in Japan. The study detected MAEs and found 221 giving an MAE rate of 0.28/1000 patient days. A study at a single NHS mental-health Trust in the UK was conducted by Maidment and Thorn (2005). The study used similar methods as in the previous study by Ito and Yamazumi (2003) but the researchers investigated administration, dispensing and prescribing errors in a 12-month period. This study found that the MAEs constituted 50 errors from a total of 66 medication errors reported and the MAE reporting rate was 4.1/month. It becomes apparent just by looking at these two studies that the way in which MAEs measured via incident reports are reported in different studies is not standardised making comparisons very difficult. While the Ito and Yamazumi (2003) study reported using incidence per 1000 patient days, the Maidment and Thorn (2005) used incidence per month.

Haw and Cahill (2011) conducted another study based at a psychiatric hospital in the UK. They investigated administration, dispensing and prescribing errors by using a prospective design examining the internal reporting system during a 2-year period. The study illustrated that the medication administration errors were 88.8% (424) from a total of (446) medication errors found. Again, although this study gives an indication of what proportion of all errors were due to MAEs, it does not give an incidence rate using standardised units for the purpose of comparison with other studies.

In addition, a retrospective study was found which was based on examining administration errors reported on an incident reporting system over a 42-month period by Haw et al. (2005), at a psychiatric hospital in the UK. The main concern was to identify the MAEs that had occurred at this hospital. The researchers found 112

administration errors had been reported on the incident forms resulting in a reporting rate of 2.67 MAEs per month.

Overall, the number of MAEs found in these studies using the incident report were very low compared with the studies using chart review (Grasso et al., 2003, Haw et al., 2007) and compared to the studies used the observational method which will be explained later. According to Stetina et al. (2005), MAE rates from incident reports are considered to generally underestimate the occurrence of actual errors. Another problem is that, as alluded to above, incident reports cannot return an overall MAE *rate* unless a denominator is known (i.e. total number of doses given over the period covering reporting) and when other non-standardised reporting units are used, comparisons again become difficult. This problem is illustrated in a systematic review study by Maidment et al. (2008) where the overall error rate could not be calculated due to incident reports studies using different denominators.

Instead, the observational method is considered the most reliable and common method for detecting MAEs on different wards and countries, not least of all because it provides a way of standardising the error rate. The MAE rate is calculated in these studies by dividing the errors found through observation by the total opportunity of error (OE) (detailed later in this thesis) before multiplying by 100. The studies using the observational method for detecting MAEs can be divided into three main varieties; the observational study of non-IV medication, the observational study of only IV medication and the observational study of all medications group (McLeod et al., 2013).

To be relevant to the current research, the focus in this section is on observational studies using paper drug charts, starting with a number of studies observing non-IV MAEs. A study by Dean et al. (1995), compared the MAE rate of UK and USA

hospitals. The study was located in 6 general hospital wards in both countries for a 2-month duration in the UK and a 1-month duration in the USA. The study showed a lower MAE rate in UK of 3% compared with 6.9% in the USA. A similar study conducted for a 3-month duration again compared the MAE rate between two countries (Taxis et al., 1999). This study found a higher MAE rate in the UK at 8.0% (67/842) and lower one in Germany at 5.1% (50/973) when comparing a standard ward setting; and 2.4% (32/1318) for a different ward system in Germany. Furthermore, a study by Ho et al. (1997), placed in one elderly female care ward in the UK for only 16 days duration found the MAE rate to be 5.5% (119/2170). From these studies then, one might infer that the observational method returns an MAE rate of between 3% and 8% for standard wards (i.e. general acute care hospital wards and not counting IV medication).

The error rate does depend on what is actually counted as an error, however. For example, a study by Chua et al. (2010), completed at two paediatric wards in a teaching hospital in Malaysia over a 3-month duration measured the MAE rate including wrong-time errors and reported an error rate of 11.7% (100/857), which was lower at 7.8% (67/857) when wrong time errors were not included. The setting of the study also matters. For example, a study by Soerensen et al. (2013), conducted at Aalborg university hospital, Denmark, on three adult psychiatric wards showed an MAE rate that was much higher at 42% (142/340). In contrast, a study by Cottney and Innes (2015), completed at one NHS psychiatric hospital, on 43 inpatient wards in the UK found that MAE rate was 3.3% (139/4177). Kelly et al. (2011), looked at errors in patients with dysphagia in four acute hospitals, and eight wards in the UK and showed a very high MAEs rate of 38.4% (817/2129). An observational study by Ridge et al. (1995), completed at one general hospital, on six wards in the UK found that MAE rate

was 3.5% (115/3312). What becomes apparent from comparing the overall MAE rate reported in these studies is that the rate is not the same across different studies. This could be due to many reasons relating to the data collection and reporting of the rate, or it could genuinely reflect differences in actual practice and errors made.

On the point about differences being down to actual practice rather than an artefact of the research methods, an obvious example to consider relates to IV medication. Studies have consistently shown that when IV medications are observed the MAE rate is much higher than for non-IV studies. An example is a study by Hartley and Dhillon (1998), completed at one hospital, in two surgical and one medical ward, in the UK over 39 days. This study showed that the MAE rate was 26.9% (86/320). Similarly, there is a study by Bruce and Wong (2001), completed at one acute admissions ward in the UK for four weeks. This study measured the MAE rate, including wrong time errors, to be 25.2% (27/107) and 10.3% excluding wrong time errors. Another study by Taxis and Barber (2003b), for 7-month duration period at two general hospitals and ten wards in the UK, which again focussed on IV medication found a very high MAE rate of 49% (212/430). All observational studies mentioned above used the paper drug charts, not electronic drug charts. On the other hand, a systematic review study focused in all MAEs studies that have used direct observation in different countries by Keers et al. (2013b), found that the median of MAEs rate was 19.6% (8.6-28.3%) including wrong time errors and 8.0% (5.1-10.9%) without wrong time errors. Also, the median of MAEs rate when observing only IVs was 53.3% (26.6-57.9%) excluding wrong time errors comparing to 20.1% (9.0-24.6%) when all routes were observed. To summarise and reiterate, from the previous studies using the observation method the MAEs rate reported is vastly different from one study to another. Focusing on UK hospitals using paper drug chart, in adult general hospital wards, the MAE rate in some studies that

include non-IV group of medications report a rate between 3% and 8% (Dean et al., 1995, Ho et al., 1997, Taxis et al., 1999). The study by Kelly et al. (2011), conducted at acute hospitals in the East of England showed an MAE rate of 38.4% for patients with dysphagia but this could be due to the complexity of the condition. The rate of MAEs in the UK studies which observed IV administration was between 10% and 49% (Hartley and Dhillon, 1998, Bruce and Wong, 2001, Taxis and Barber, 2003b). Thus the MAE rate for IV administration is higher than MAE rate found in non-IV administration, and McLeod et al. (2013), estimates the chance of error is five times more likely in IV than non-IV doses. Focussing on MAEs using observational studies located in mental-health wards in the UK the MAE rate is between 3.3% and 48% (Alshehri et al., 2017). However, still there are no studies exist for community hospital wards and this was also suggested as area for future work by Maidment et al. (2008).

1.3.4 Type of MAEs detected in previous studies

The types of MAEs reported in most of the UK studies observing the administration of non-IV medications on wards using paper drug charts are almost similar. Omission is the most frequent type of MAE in these studies; however, the second most frequent type is different between studies. For example, an observational study by Dean et al. (1995), in general hospital wards, found that omission is the most frequent type followed by incorrect doses. Another observational study conducted in an elderly care ward by Ho et al. (1997), found that omission is the most frequent type of error then 'other omission' is second and incorrect dose third. Also, Taxis et al. (1999), found that omission is the highest type followed by incorrect preparation. Also, Kelly et al. (2011) found that wrong time error is the most frequent type then wrong preparation. Another study placed in psychiatric wards completed by Cottney and Innes (2015), showed that

omission was also the highest error type with wrong dose being the second highest type. On the other hand, Haw et al. (2007), reported that crushing tablets without authorisation was the most frequent type of MAE in their study followed by omissions. According to the systematic review study completed by Alshehri et al. (2017) omissions and wrong time errors were reported to be the two most frequent MAE types on the MAEs studies focused in psychiatric wards. The differences in MAE types of the previous studies could be due to the methodological approaches used for classifying and recording the error type. In Haw et al. (2007), the researchers classified behaviours such as unauthorised crushing of tablets as administration errors, whereas Cottney and Innes (2015), suggested that this does not represent as an actual administration error. Furthermore, the frequency variation of MAE types in these studies could be because of the different type of wards observed in each study (see Table 1.3).

1.3.5 The potential for harm from MAEs

The potential for harm which is also called severity of errors has been measured in some of the UK studies. Each of these studies has used different methods for rating the error severity as well as different techniques for severity judgement. For example, the severity of error can be categorised according to four classifications; negligible, minor, serious effects, or fatality (Haw et al., 2007). This classification was also adopted in the study by Cottney and Innes (2015), where reported errors were individually verified by a senior pharmacist to ensure that it had been classified correctly as well as represented an accurate administration error. In the study by Haw et al. (2007), the severity of error was rated by three researchers.

Furthermore, in a study by Haw and Cahill (2011), the severity of errors was rated into five levels according to the organisation accident and severity scale; level one (near

miss), level 2 (minor), level 3 (moderate), level 4 (serious), and level 5 (life threatening). One pharmacist and one senior pharmacist rated the severity of errors using inter-rater reliability which means that both pharmacists individually rated some of the medication errors, and then compared the errors to judge the degree of agreement.

Looking at the actual findings, most previous studies that have observed the administration of non-IV medications have categorised the majority of MAEs either as minor or negligible in terms of their severity (Haw et al., 2007, Haw and Cahill, 2011, Cottney and Innes, 2015). A systematic review study focusing on the MAEs in hospital inpatients used observational methods, by Berdot et al. (2013), and found that most MAEs in observation studies were classified as minor. Also, Alshehri et al. (2017) in a systematic review study showed that the majority of MAEs were classified as minor in their severity in psychiatric wards. A study by Taxis and Barber (2003b), observed administration of IV medications and used a validated scale between zero (no harm) and 10 (death) which mean scores below three were classified as minor, 3-7 scores classified as moderate, and above seven as severe. Here, the severity of error was rated by one doctor, one nurse and two pharmacists. The study found that most MAEs were categorised as potentially moderate followed by potentially minor. This finding would have arisen because only the IV route of administration was observed in that study compared to the above studies that observed non-IV route of administration. This potentially means that not only are there more errors found when IV medication administrations are observed, but that MAEs found are also more likely to be judged as severe compared to non-IV MAEs.

Table 1.3: Studies that investigated MAEs in different hospital settings

Study	Study Setting	Duration	Study design	MAE rate (Error/OE)	Most frequent type of error	Potential for harm or error severity
Dean et al. (1995)	1 general hospital, 2 surgical, 2 medical, 2 elderly care wards, UK 1 general hospital, 6 wards, USA	2-month duration, UK 1-month duration, USA	Observational study for non-IV medication	3% of (2756) OE, UK 6.9% of (919) OE, USA	UK, Omission 58% Incorrect doses 14% USA, Incorrect doses 30% Unordered doses 25%	
Ridge et al. (1995)	1 general hospital, 6 wards, UK	1-week for each ward	Observational study for (oral, IV, etc.) medication	3.5% (115/3312)	Non-available 51% Omission 27% Wrong dose 17%	
Ho et al. (1997)	1 elderly female care ward, UK	16-days duration	Observational study for non-IV medication	5.5% (119/2170)	Omission (drugs not available) 26% Other omission 24% Incorrect dose 16%	
Hartley and Dhillon (1998)	1 hospital, 2 surgical and 1 medical ward, UK	39-days duration	Observational study for IV medication	26.9% (86/320)	Wrong time 52.5% Omission 12.5% Wrong preparation technique 7.2%	Minor 77.9% Moderate 17.3% Major 4.7%
Taxis et al. (1999)	1 general hospital, UK 1 general hospital, Germany	3-month duration	Observational study for non-IV medication	UK 8.0% (67/842) Germany 5.1% (50/973) 2.4% (32/1318)	UK, Omission Incorrect preparation Germany, Omission	Most of errors were minor
Bruce and Wong (2001)	1 acute admissions ward, UK	4-week duration	Observational study for IV medication	Include wrong time error 25.2% (27/107) Exclude wrong time error 10.3%	Wrong time 17% Wrong preparation technique 5%	

Study	Study Setting	Duration	Study design	MAE rate (Error/OE)	Most frequent type of error	Potential for harm or error severity
Taxis and Barber (2003)	2 general hospital, 10 wards, UK	7-month duration	Observational study for IV medication	49% (212/430)	Giving bolus doses too quickly Mistakes in preparing drugs	Potentially minor 19% Potentially moderate 29% Potentially severe 1%
Grasso et al. (2003)	1 psychiatric hospital ward, USA	5-month duration	Retrospectively chart review for random 31 patients compare with the incident report (self-report)	(1443/ 21,033) 6.8% And only 9 incident reports	Scheduled dose is not documented as administered 61.9%	Low risk of harm 19% Moderate risk 23% High risk 58%
Ito and Yamazumi (2003)	44 private psychiatric hospitals, Japan	2-month duration	Prospective incident report	0.28/1000pt.-days 221 MAEs incident report received	Wrong drug 35.7% Wrong time 19.9% Dose omission 15.8%	Clinical significant 57% Potential significant 15 Potential serious 29%
Balas et al. (2004)	Nurses working in different hospital units (medical/ surgical and in intensive care units), USA	28-days duration	Prospective incident report (self-report)	56% from 199 errors related to MAEs	Wrong time errors 33.6% Wrong dose 24%	
Haw et al. (2005)	Tertiary private psychiatric Hospital, UK	42-month duration	Retrospective incident report	2.67/month	Improper dose 31% Wrong drug 21% Omission 17%	Minimal significance 77% Moderate significance 14% Potentially serious 1% Fatality 0%

Study	Study Setting	Duration	Study design	MAE rate (Error/OE)	Most frequent type of error	Potential for harm or error severity
Maidment and Thorn (2005)	Single NHS mental-health trust, UK	12-month duration	Prospective incident report	4.1/month	Wrong frequency 13 Mismatching between patient and medicine 12	Low severity 40 Moderate 23 High 3
Balas et al. (2006)	Several hospitals critical care units, USA	28-days duration	Prospective incident report (self-report)	56.7% (127)	Wrong time error 38% Omitted dose 22%	
Haw et al. (2007)	2 elderly long-stay psychiatric wards, UK	3-month duration	Direct observation Chart review Incident report	25.9% (369/1423)	Crushing tablets without authorisation 28.7% Omission 27.1%	Negligible 69.1% Minor 7.3% Serious 0.3% Fatality 0% Unrateable 23.3%
Chua et al. (2010)	1 teaching hospital 2 paediatric wards, Malaysia	3-month duration	Observational study	With wrong time 11.7% (100/857) Without wrong time 7.8% (67/857)	Wrong time 28.8% Wrong preparation 26%	Probably clinically insignificant 9.6% Minimal clinical significance 50% Definitely clinically significant 40.4%, potentially life-threatening 0
Haw and Cahill (2011)	Large specialist Psychiatric hospital, UK	2-year duration	Prospective incident report	88.8% from 446 errors related to MAEs	Missing signature 27.8% Omission 18.2% Wrong dose 12.1%	Significant 19.7% Minor 74.0% Moderate 5.4% Serious 0.9%

Study	Study Setting	Duration	Study design	MAE rate (Error/OE)	Most frequent type of error	Potential for harm or error severity
Kelly et al. (2011)	4 hospitals, 8 wards, UK	4-month duration	Observational study for non-IV medication	38.4% (817/2129)	Wrong time error 72% Wrong preparation 8%	
Agalu et al. (2012)	1 Intensive care unit (ICU), Ethiopia	47-days duration	Direct observational method with chart review	51.8% (621/1200)	Wrong time error 30% Omission 29%	
Soerensen et al. (2013)	3 adult psychiatric wards at Aalborg university hospital, Denmark	4-month duration	Direct observational method	42% (142/340)	Lack of identity control 95% Wrong time error 6%	Nonsignificant 20% Significant 27% Serious 51% Fatal 1%
Cottney and Innes (2015)	NHS psychiatric hospital, 43 inpatient wards, UK	-------	Observational study for non-IV medication	3.3% (139/4177)	Omission (52/139, 37%) Wrong dose (25/139, 18%) Wrong form (16/139, 12%)	Negligible 19% Minor 71% Serious 11% Fatality 0%

1.3.6 Contributing factors and causes linked to MAEs

There are many papers published on MAEs in different hospital wards around the world. However, only some of these studies have looked at the contributing factors linked to MAE rates and some viewed the causes behind MAEs. Keers et al. (2013a) indicated the causes of MAEs either from the reasons that were described directly from the responsible person to the researcher or were provided from the direct observation data. On the other hand, the contributing factors are "the factors that influence staff performance, and which may precipitate errors and affect patient outcomes" (Taylor-Adams and Vincent, 2004). The studies that considered the contributing factors for example include, a study by Tissot et al. (2003), using observation technique at two wards university hospital in France, which identified that nurse workload is one of the important risk factors of MAEs. An observational study conducted within two wards at teaching hospital in Spain by Rodriguez-Gonzalez et al. (2011) is also relevant. That study concluded that the morning medications administration rounds could increase the risk of administration errors. Another study by Balas et al. (2006), reported the most common reasons of error included simply forgetting or heavy workload and interruption. Also, Westbrook et al. (2010), who used direct observation at two major teaching hospitals in Sydney, and divided MAEs according to procedural errors and clinical errors, showed that interruption increase procedural errors by 12.1% and increase the clinical errors by 12.7%.

In addition, Cottney and Innes (2015), who used the observational method in a mental-health hospital, found that MAEs were 48% more likely to occur when the nurse administering the medication was interrupted; the other contributing factors were the number of PRN (when required) doses given which increased the risk of error by 15%,

total number of patients on the ward at the time of the medication round which increased the risk of error by 6%, and the number of regular doses due which increased the risk of error by 2%. Both the Westbrook and Cottney studies used the Generalized Linear Model (GzLM) to analyse the statistical relationship between any contributing factors and MAEs. The Generalized Linear Model is a statistical model used to analyse the combination of predictors (contributing factors) with regard to the occurrence of MAEs (Cohen et al., 2013, Hayat and Higgins, 2014). A similar method was used in the current study as outlined in Chapter 3. Furthermore, a comprehensive review by Procyshyn et al. (2010) found different reasons that increase the risk of MAEs in psychiatric wards such as shortage of staff, the ward being busy with other activity, noisy work environment, distractions, feeling tired, weak concentration, and weak supervision.

As well as the factors on the ground which increase the risk of MAEs, Keers et al. (2013a), through a systematic review study have provided robust data concerning the causes of MAEs when analysed using Reason's model of accident causation. The results showed that slips and lapses were the most significant 'unsafe acts', followed by knowledge-based mistakes and violations. Keers et al. (2015), used a semi-structured interviews with nurses in two teaching hospitals in England, identified that slips and lapses were the more detected active failure than mistakes and violations. Moreover, distractions, workload and poor staffing are considered as the error-producing conditions that cause slips and lapses (Keers et al., 2013a). Also, workload is commonly a contributing factor to slips and lapses, as well as contributing to violations and mistakes (Keers et al., 2015). Also, a study by Keers et al. (2016), used a semi-structured interviews with nurses in mental-health settings, showing that in psychiatric ward workload is the main error-producing condition. Keers et al. (2013a), stated that

MAEs are influenced by many system factors; however, further investigations are needed because of lack of consistency between the different studies. Reason's model of accident causation classifies the stages of error according to: active failures or unsafe acts e.g. (slips, lapses, mistakes and violations), error-producing conditions (contributory factors), and latent failures (organisation and management culture) (Reason, 1997). This is further explored in Chapter 2.

1.3.7 Suggested interventions to reduce the MAEs

It is important to examine studies and suggestions for different medication administration systems or other interventions that might help to reduce the occurrence of MAEs. One of the suggestions is to replace the traditional practice in general hospital wards using a drug trolley with bedside-patient lockers using the 'one-stop' dispensing system (NPC, 2007, 2008). One-stop dispensing can potentially help to reduce risks associated with medicines administration and make better use of nurses' time (NPC, 2007, 2008). Many benefits of this set up have been advocated including a reduction in pharmacy dispensing times, faster discharge for patients, reduction in medication errors, smoother transition to primary care, improved patient compliance, reduction in time spent on medication rounds, better drug-history taking, provision of patient information leaflets, improved working relationships on the ward, as well as reduced waste and cost (NPC, 2007, 2008).

In reality, there are also published studies examining the impact of one-stop dispensing using a number of outcome measures. While on the whole research shows a positive impact, one potential difficulty is that different studies have used different outcome measures and different designs making it difficult to truly compare the benefits of bedside-patient lockers and one-stop dispensing in terms of MAEs. Two studies

associate one-stop dispensing with a reduction in the MAE rate. In a before and after study, Hogg et al. (2012), reported a reduction of the total MAE rate from 8.3% before to 1.3% after the introduction of the patient medication lockers at one research site and from 9.9% before and 3.2% after locker introduction in another; the results were statistically significant and showed a positive impact in terms of patient safety. Camac et al. (1996), used a comparative design with patient lockers versus ward medication drawers, finding that (when injections were removed from the sample), significantly more medication errors occurred using the ward system, 25 (18%) compared to the bedside system, 7 (7%), and these results too were deemed statistically significant. In contrast, Dean and Barber (2000), found that there is no difference between the uses of bedside medicine cabinets versus the traditional system on the occurrence of MAE rates (4.2% vs. 4.3%).

Also, there is one study that has examined the impact of one-stop dispensing on missed doses. Agha et al. (2008), examined the incidence of missed doses in two wards before and after the implementation of one-stop dispensing and found a decrease in the number of missed doses after one-stop dispensing (80 miss doses after; compared with 216 before). A dose of a medication can be considered a 'missed-dose' for a number of reasons relating to a) intention to prescribe but not prescribed; b) medicine not available or in fact not found (either during normal working hours or out of hours); c) medicine not administered (e.g. patient refused or nurse forget); d) patient not on ward; e) unfamiliar preparation, administration, method or device; f) route of administration not available; g) medicine administered to wrong patient; h) discharge medicine not supplied. Clearly, one-stop dispensing could impact most obviously on reasons (b), (c), (g), and (h). However, since there is only one study examining the impact of one-stop dispensing on missed doses, and this was reported only as a conference abstract, there is

no clear evidence about which types of missed doses are tackled by patient lockers. The other point to note is that these studies focused on either acute medical or surgical wards. There is no formal assessment of the use of patient lockers on community hospital wards in the UK.

In addition to bedside-patient lockers as a way of reducing MAEs, another suggestion by Barber et al. (2003), is the use of technology to control people's actions. There are published articles examining the effect of technology in reducing the MAEs. A study by Franklin et al. (2007) is relevant, this was a before and after observational study located at a general surgical ward in the UK. The work illustrated the reduction of MAE rates from 8.6% to 4.4% after implementing the electronic prescription and barcoding system for medication administration purposes. Also, Helmons et al. (2009), using before and after observational method in a general hospital in the USA, found that the MAE rate reduced by almost 2% after using a barcoding system. Another study was completed by Cottney (2014) on a psychiatric ward at East London Foundation Trust. Here, the medication administration was observed before and after the implementation of an automated dispensing cabinet. The study showed that a reduction in the medication administration error rates from 8.9% to 7.2% after using the automated dispensing cabinet, and a reduction in the time taken for administering medication from 2.94 to 2.37 minutes per dose. This reduction might increase the nursing free time by around 66 minutes per ward per day. These studies show a positive impact of technology in terms of reducing the MAE rate. However, as mentioned before, there are no studies comparing mental-health and community hospital wards, using paper drug charts, where some of the community wards use bedside-patient lockers for medication administration.

Moreover, the impact of specific interventions such as the use of technology, training and ward system changes to reduce MAEs in hospitals were outlined in a systematic review study by Keers et al (2014). The paper showed a reduction in MAE rates being reported by technology and education training studies. On the other hand, Berdot et al. (2016) found in their systematic review that the overall MAE rate was not different in the studies comparing between the intervention and the control groups; however, in the before-and-after intervention studies, the MAE rates decreased after the intervention.

Furthermore, there are other studies that have introduced different interventions resulting in reduced MAEs. For example, a study by Cottney (2015) showed a reduction in the average missed dose rate on the six wards specialising in the mental healthcare of older people in East London Foundation Trust from 1.07% to 0.07%. This study was a quality improvement project, where the number of missed doses was ranked for each wards and published in a fortnightly league table. Another example is an audit study by Dawson (2014) completed at two NHS dementia units by using an intervention. The intervention included training sessions for nursing staff encouraging them to report the blank boxes as MAEs. The study showed that MAEs on dementia units decreased in ward A from 5.3% to 0.8% and ward B from 1.7% to 0.2%. In psychiatric hospital ward there is an interview study by Haw et al. (2015) which found that the participant nurses need training on medicines management due to a lack of awareness with UK medicines management guidance and local policy e.g. (nurses would not report an MAEs or near miss medications). These show the importance of nurses' continuing education and training on medication safety and reducing MAEs.

In addition, another example of what helps to reduce MAEs, a systematic review study by Alsulami et al. (2012) found that the double-checking by other nurses reduce the

errors in a few studies. Also, the study stated that more investigations need to examine the effectiveness of double-checking medicines in decreasing MAEs due to scarcity of evidence. However, the double-checking can be by delegating the drug administration to other nurses or care workers as shown in observation study in two busy elderly psychiatric wards by Dickens et al. (2008). That study illustrated that there were no more likely to be errors when care workers administered the medication to the patients. Also, care workers administering drugs to disorderly and violent patients were deemed to be more possible than registered nurses doing this. The study suggested that on busy elderly psychiatric wards delegation of drug administration is a viable option and delegated care workers must be trained regularly for the safety aspect. Moreover, a study evaluated nurses' knowledge of double-checking medication administration by (Alsulami et al., 2014) finding that the nurses had a lack of awareness and clarity about double-checking. The study stated that training might improve nurses' double-checking knowledge and improvements in patient safety. As the interruptions increased the risk of MAEs as mentioned earlier, a systematic review by Raban and Westbrook (2013) evaluated evidence of the interventions' efficiency in decreasing the interruptions rate during the administration round and MAEs rate. The study found some evidence on reduction of the interruption rate after using the interventions and fewer evidence of interventions effectiveness to reduce MAEs.

1.4 Aim

The overall aim of this study is to examine the rate of MAEs as well as the contributing factors and the causes behind the MAEs across all wards at BHFT in order to examine whether there are differences between psychiatric and community hospital wards, which use different modes of drug administration and also focus on different

therapeutic areas. The purpose is also to produce recommendations for improving medication administration practices in these types of settings.

1.5 Objectives

Two main objectives were considered to achieve the aim of this study:

1- To identify the rate of MAEs for psychiatric wards and community hospital wards through the observational method. The quantitative outcomes being measured are:
   a) The number and type of MAEs.
   b) A range of possible contributing factors including administration times, interruptions, staff shortages and medication administration practices.

This objective included to decipher a formal method for meaningfully analysing the quantitative data using inferential statistics.

2- To examine the perceived causes and wider factors contributing to these errors through qualitative methods. The qualitative data collection will involve:
   a) In-depth examination of the researcher's notes made during the observations.
   b) Speaking with relevant healthcare professionals (nurses and pharmacists) in semi-structured interviews to gain their opinions and perceptions about the MAEs found within the Trust.

This second objective included to interpret these data using an appropriate error causation framework. This study received approval from the University of Reading Research Ethics Committee and the Trust Clinical Audit department to proceed.

1.6 Structure of the thesis

Chapter one has presented an introduction to MAEs, definitions, and methods used to determine MAEs. It then reviewed literature about the rate of MAEs and type and

frequency of MAEs, potential for harm, contributing factors linked to MAEs and interventions to reduce the MAEs. This chapter has also provided an overview of the study aim and research objectives and below introduces the outline of the thesis.

Chapter two describes the research methodology, theoretical framework related to medication errors, including human error theory, 'Swiss Cheese' model and the organisational accident model. It also describes methodology relating to pharmacy practice, research design, and techniques employed to meet the research objectives. Next, the data collection, including the sample size and recruitment, ethical issues, payment and data protection and confidentiality are detailed. The chapter concludes with the detail of the methods used for the quantitative and qualitative data analysis.

Chapter three reports on the quantitative results and findings of this thesis, firstly the descriptive data analysis is shown followed by the inferential statistical analysis and analysis using the Poisson Regression Model.

Chapter four reports on the qualitative results and findings of this thesis, including the comparison between the observational notes and the interviews completed with the healthcare professionals.

Chapter five focusses on the interpretation of the findings and discusses the investigation in relation to the work of other scholars.

Chapter six summarises the significant research findings, including the limitations of the study, contribution to knowledge and presents recommendations as well as suggestions for future research work.

Chapter 2 Research Methodology

The previous chapter considered some of the important literature on MAEs detailing their rates, type, potential for harm and potential contributing factors. This chapter first outlines the theoretical frameworks supporting this study and illustrates the methodological approaches and techniques drawn upon in order to answer the research objectives. This is followed by the description of the research methods actually used in this study to support the data collection (quantitative and qualitative), including the study design, sampling and recruitment, and ethical approval. This chapter concludes with a detailed description of the data analysis.

2.1 Theoretical frameworks relating to medication errors

There are a number of human error frameworks relevant to medication safety which is outlined here. First, is a conceptual model of human factors consisting of Software, Hardware, Environment, and Liveware (SHEL) has been used in studies of error in aviation (Hawkins, 1987). The SHEL model is recommended for analysing human factors in the aviation accident investigations and considers both active and latent failures (Shappell and Wiegmann, 2012). Moreover, it was used in a particular real-life example of medical error in order to examine the human errors. The SHEL model has also been used in healthcare e.g. the emergency room or the operating theatre (Molloy and O'boyle, 2005).

In addition, patient safety researchers recognise the need for human factors engineering and systems approaches to patient safety research and improvement. The US Institute of Medicine (IOM) with the application of systems engineering concepts and human factors have designed the Systems Engineering Initiative for Patient Safety (SEIPS)

model. The SEIPS model has also been used to frame the design and analysis of research (Carayon et al., 2006). Also, the model is used in the healthcare domain focusing on work systems and its different sociotechnical system models for example, to evaluate many health information technologies such as electronic health records, smart infusion pumps and bar coded medication administration (Holden et al., 2013). However, this model was criticised for having no specific guidance and as such is considered as a descriptive model (Carayon et al., 2006).

On the other hand, the Yorkshire Contributory Factors framework was published in 2012 (Lawton et al., 2012). This model is more specific to the healthcare domain and it is evidence-based. The Yorkshire framework includes 20 contributory factors which were identified from several studies. Moreover, the Yorkshire framework allows researchers and others to classify contributing factors in a clear way into four main categories: active failures, local conditions, situational factors and latent factors. However, Franklin and Garfield (2017) have stated that it is slightly more complex than the accident causation model.

This section focusses on the theoretical framework supporting this study. James Reason developed the 'Swiss Cheese' accident causation model (Reason, 1990), which has been commonly referred to in healthcare systems when examining human error and its management. This has given rise to a whole body of literature on human error inspired by the work of Reason, some of which is particularly relevant in terms of this research study.

2.1.1 Human error theory

This section provides a brief review of the concept of error, error types and human error theory in relation to healthcare. The term 'human error' describes an action or

misconduct by a human who fails to complete or achieve their task as planned, which according to Reason can be classified to three levels; conceptual, contextual and behavioural by considering origins in human cognition (Reason, 1990, p. 17). Norman (1988 as cited by Armitage, 2009), analyses human tasks or cognitive shortcuts as error types, which can occur in planning or action-based stages such as slips, lapses and mistakes Slips, lapses and mistakes are considered errors types by Reason (1990, p. 9). Slips are defined as actions that did not go as planned, whereas lapses involve memory failures. Mistakes are failures in judgement to achieve the objectives, which are deemed to be very hard to detect. Also, Rasmussen (1983 as cited by Reason, 1990) classifies human performance such as mistakes into two levels; rule-based and knowledge-based. Furthermore, Reason (2000), states that human error can be seen in two ways: using a person approach or a system approach and each has its model of error causation. According to Armitage (2009), Reason has created a template of available knowledge of individual factors combined with system factors. Parker and Lawton (2003), identify this approach as a 'human error theory'. This theory is founded from results of observational studies of error and findings of research in cognitive and social psychology laboratories.

2.1.1.1 Person approach

Person approach focused on an individual's errors caused by human who are responsible and blamed for their weakness and forgetfulness more than their organisations (Franklin and Garfield, 2017). According to Reason (2000), the tradition of the person approach is a "focus on the unsafe acts such as slips, lapses, errors and procedural violations of people at the sharp end such as nurses. It views these unsafe acts as arising primarily from aberrant mental processes such as forgetfulness, inattention, poor motivation, carelessness, negligence, and recklessness. The associated

countermeasures are directed mainly at reducing unwanted variability in human behaviour". Reason has criticised this approach because it focusses on the individual origins of error, and it separates unsafe acts from their system environment.

2.1.1.2 System approach

Reason's system approach is that where humans are involved, in workplaces and organisations, errors will occur and "errors can be seen as consequences rather than causes". The assumption of the system approach is that the human condition cannot be changed, however, conditions can be reformed under which humans' work (Reason, 2000). Also, this approach focuses on the conditions and attempts to build defences; "all hazards and technologies have barriers or defences to prevent error, it is important not concentrate on who made the error but how and why the defence failed" (Reason, 2000).

2.1.2 The 'Swiss Cheese' and the organisational accident model

The 'Swiss Cheese' model in relation to errors was developed by Reason in 1990 and is widely used in accidental analysis. Specifically, this model is widely used in examining medication errors, such as prescribing, dispensing and administration where there is a potential to either make or prevent an error (Sanghera et al., 2007). According to Reason (2000), the concept of safety is embodied by layers of 'Swiss Cheese' with *holes* in the safety layers corresponding to the deficiencies due to latent errors e.g. organisational errors, environment etc. (Figure 2.1). The holes in the defences appear for two reasons, active failures and latent conditions, and when the holes in the defensive layers align, then the hazard can lead to an accident. Almost all adverse events include a combination of two sets of these factors. Active failures; are the 'unsafe acts' committed by people who are in direct contact with the patient or system.

They take a variety of forms: slips, lapses, fumbles, mistakes, and procedural violations. "Active failures have a direct and usually short-lived effect on the integrity of the defences. Latent conditions; are the predictable 'resident pathogens' within a system. They arise from decisions made by designers, builders, procedure writers, and top level management. These decisions may be mistakes but they need not be. All such strategic decisions have the potential for introducing pathogens into the system" (Reason, 2000).

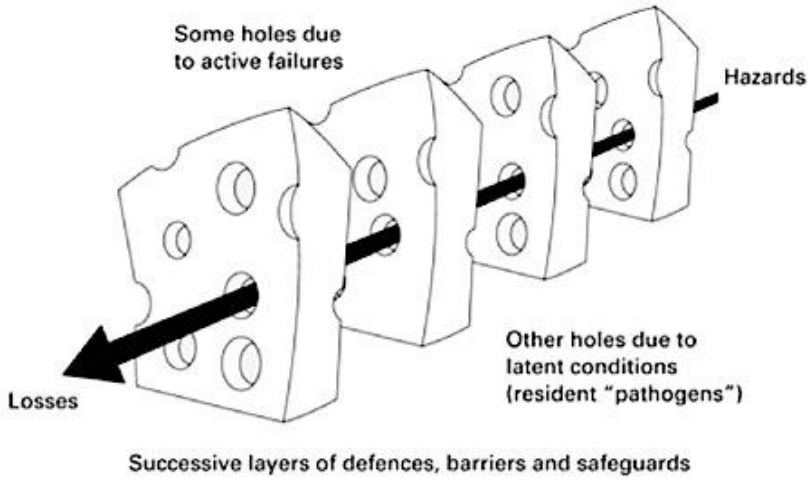

Figure 2.1: The Swiss Cheese model (adapted from Reason, 2008)

According to Ahmad and Pontiggiaa (2015), the main aspect of the organisational accident model is that latent conditions interact with the local error-producing conditions, and in cases where safety barriers are unavailable, this could lead to an accident (Figure 2.2). Thus organisational accidents can result when the latent conditions combine with active failures at the 'sharp end' – i.e. errors or violations due for example to high workload, time pressure and experience and poor equipment with local producing factors to break the system defence (Reason, 2008, p. 96). Each organisational accident has at least three common features: hazards, failed defence and losses (damage to people or environment). The failed defences are more useful for

effective prevention; however, no defence is perfect. The gap in the defences can be as a result of two reasons; active failure and latent conditions as represented in the 'Swiss Cheese' model (Reason, 2016) (see Figure 2.1).

Furthermore, in the 'lining-up' of the gap there is a need for making a strong path through the defences. In this way, organisational accidents include the improbable combination of numerous factors at several levels of the system which breach the many defences, barriers and safeguards (Reason, 2016, p. 11). The stages in the development of an organisational accident are presented in Figure 2.2 below. This model aims to link the several contributing features into a consistent sequence that runs bottom-up in 'causation' and top-down in 'investigation'. The top block illustrates the main elements of an event and the bottom shows the system producing the contributing features, which has three stages: the person (unsafe acts), the workplace (error-producing conditions), and the (organisation) (Reason, 1997).

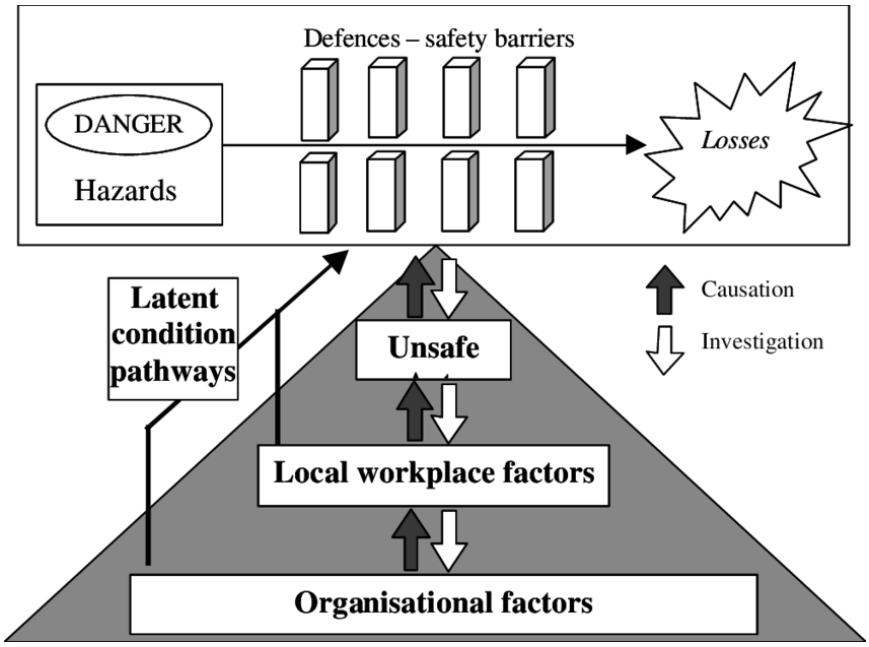

Figure 2.2: Stages in the development and investigation of an organisational accident (Reason, 1997)

As noted by Franklin and Garfield (2017), this model has been adapted to healthcare (Vincent et al., 1998) and it has been used to understand medication errors (Dean et al., 2002, Taxis and Barber, 2003a).

2.1.3 The model adopted for this study

Taylor-Adams and Vincent (2004) developed an 'adapted' organisational accident causation model based on a framework developed by Vincent et al. (1998), which was itself modelled on Reason's model of organisational accidents (Reason, 1997). This adapted model assists the researcher in classifying the stages of error causation: *active failures* which are unsafe acts such as slips, lapses, mistakes and violations, committed by humans at the sharp end of operations, with *error-producing conditions* which are contributory factors such as patient factor, task factor, individual factor, team factor, or work environment factors, as well as with *latent failures* which are organisation and management culture such as organisational processes and management decisions (see Figure 2.3). Using the framework allows an in depth way in which errors can be categorised and classified in accordance with the error-producing conditions and latent failures so that ultimately one can understand the factors affecting the safety of clinical practice (see Table 2.1).

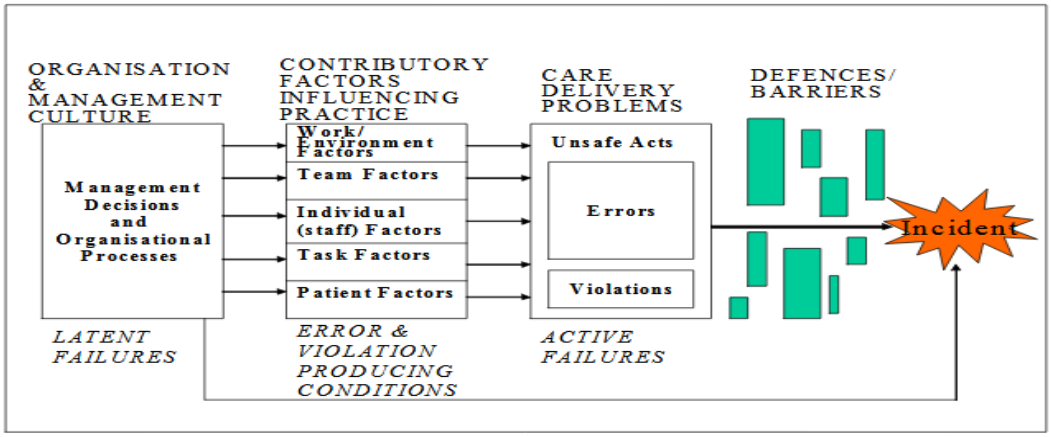

Figure 2.3: The organisational accident causation model (adapted from Taylor-Adams and Vincent, 2004)

Table 2.1: Framework of contributory factors influencing clinical practice (Vincent et al., 1998)

FACTOR TYPES	**CONTRIBUTORY INFLUENCING FACTOR**
Patient Factors	Condition (complexity and seriousness) Language and communication Personality and social factors
Task and Technology Factors	Task design and clarity of structure Availability and use of protocols Availability and accuracy of test results Decision-making aids
Individual (staff) Factors	Knowledge and skills Competence Physical and mental health
Team Factors	Verbal communication Written communication Supervision and seeking help Team structure (congruence, consistency, leadership, etc.)
Work Environmental Factors	Staffing levels and skills mix Workload and shift patterns Design, availability and maintenance of equipment Administrative and managerial support Environment Physical
Organisational & Management Factors	Financial resources and constraints Organisational structure Policy, standards and goals Safety culture and priorities
Institutional Context Factors	Economic and regulatory context National health service executive Links with external organisations

One of the elements of the current research was to classify errors according to the active failure category as well as the contributing factors. But the classification of an error as a particular type of active failure is not a straightforward process because the characteristics of the error need to be considered in detail and then a judgement needs to be made about the failure type the error represents. In view of this, Figure 2.4 and Table 2.2 show the active failure types and their definitions according to the Health and Safety Executive (HSE), which is the national independent watchdog for work-related health, safety and illness. These resources were used by the researcher here to identify the meaning of these categories when the observation notes and interviews quotes were being analysed in order to stipulate the possible cause of the errors observed.

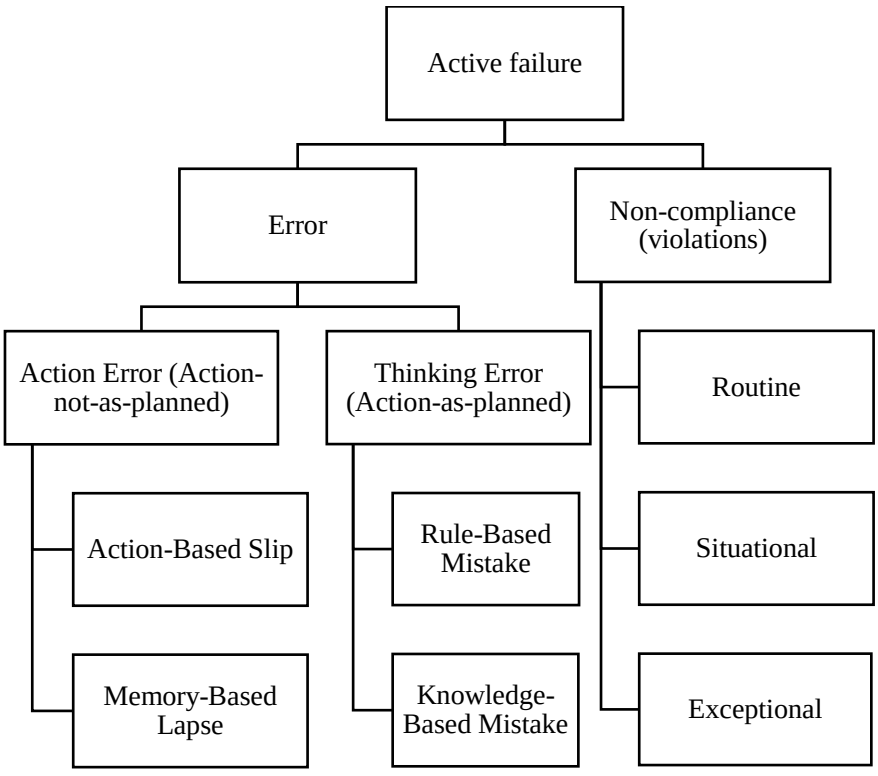

Figure 2.4: Human failure type (adapted from HSE, 2017)

Table 2.2: Human failure type explanation (adapted from HSE, 2017)

	Characteristics	Failure Type	Examples	Typical Control Measures
Action Error	Associated with familiar tasks that require little conscious attention. These 'skill-based' errors occur if attention is diverted, even momentarily.	Slip (Commission)	A simple, frequently-performed physical action goes wrong: • Flash headlights instead of operating windscreen wash/wipe function • Move a switch up rather than down (wrong action on right object) • Take reading from wrong instrument (right action on wrong object) • Transpose digits during data input into a process control interface	• Human-centred design (consistency e.g. up always means off; intuitive layout of controls and instrumentation; level of automation etc.) • Checklists and reminders; procedures with place markers' (tick off each step) • Independent cross-check of critical tasks (PTW) • Removal of distractions and interruptions • Sufficient time available to complete task • Warnings and alarms to help detect errors • Often made by experienced, highly-trained, well-motivated staff: additional training not valid
	Resulting action is not intended: 'not doing what you meant to do'. Common during maintenance and repair activities.	Lapse (Omission)	Short-term memory lapse; omit to perform a required action: • Forget to indicate at a road junction • Medical implement left in patient after surgery • Miss crucial step, or lose place, in a safety-critical procedure • Drive road tanker off before delivery complete (hose still connected)	
Thinking Error	Decision-making failures; errors of judgement (involve mental processes linked to planning; info. gathering; communication etc.)	Rule-Based Mistake	If behaviour is based on remembered rules and procedures, mistake occurs due to mis-application of a good rule or application of a bad rule: • Misjudge overtaking manoeuvre in unfamiliar, under-powered car • Assume £20 fuel will last a week but fail to account for rising prices • Ignore alarm in real emergency, following history of spurious alarms	• Plan for all relevant 'what ifs' (procedures for upset, abnormal and emergency scenarios) • Regular drills/exercises for upsets/emergencies • Clear overview / mental model (clear displays; system feedback; effective shift handover etc.) • Diagnostic tools and decision-making aids (flowcharts; schematics; job-aids etc.) • Competence (knowledge and understanding of system; training in decision-making techniques) • Organisational learning (capture and share experience of unusual events)
	Action is carried out, as planned, using conscious thought processes, but wrong course of action is taken: 'do the wrong thing believing it to be right'	Knowledge-Based Mistake	Individual has no rules or routines available to handle an unusual situation: resorts to first principles and experience to solve problem: • Rely on out-of-date map to plan unfamiliar route • Misdiagnose process upset and take inappropriate corrective action (due to lack of experience or insufficient / incorrect information etc.)	
Non-compliance	Deliberate deviations from rules, procedures, regulations etc. Also known as 'violations'	Routine	Non-compliance becomes the 'norm'; general consensus that rules no longer apply; characterised by a lack of meaningful enforcement: • High proportion of motorists drive at 80mph on the motorway • PTWs routinely authorised without physical, on-plant checks	• Improve risk perception; promote understanding and raise awareness of 'whys' & consequences (e.g. warnings embedded within procedures) • Increase likelihood of getting caught effective supervision • Eliminate reasons to cut corners (poor job design; inconvenient requirements; unnecessary rules; unrealistic workload and targets; unrealistic procedures; adverse environmental factors) • Improve attitudes / organisational culture (active workforce involvement; encourage reporting of violations; make non-compliance 'socially' unacceptable e.g. drink-driving).
	Knowingly take short cuts, or fail to follow procedures, to save time or effort.	Situational	Non-compliance dictated by situation specific factors (time pressure; workload; unsuitable tools & equipment; weather); non-compliance may be the only solution to an impossible task: • Van driver has no option but to speed to complete day's deliveries	
	Usually well-meaning, but misguided (often exacerbated by unwitting encouragement from management for 'getting the job	Exceptional	Person attempts to solve problem in highly unusual circumstances (often if something has gone wrong); takes a calculated risk in breaking rules: • After a puncture, speed excessively to ensure not late for meeting • Delay ESD during emergency to prevent loss of production	

2.2 Research methodology relating to pharmacy practice

2.2.1 Research design

There are three broad approaches for designing a practice based research study investigating healthcare practices; these involve qualitative, quantitative, and mixed methods. Therefore while research studies can be divided into either quantitative or qualitative studies sometimes both approaches are adopted (mixed-method) for a synergistic effect. Each approach is associated with its own data collection methods such as observations, interviews or questionnaires but mixed-methods studies combining a number of data collection methods (Creswell, 2013). This research study adopted the mixed-methods research design (using both quantitative and qualitative approaches). The quantitative data was derived from the direct observation of medication administration rounds, which was used to detect the rate, type, and frequency of MAEs and any contributing factors at all the hospital wards. Qualitative data was generated through the analysis of the observational notes and transcripts of semi-structured interviews with nurses and pharmacists working at the research site.

2.2.2 Quantitative approach

Quantitative research is a scientific and empirical approach that is used to understand a phenomenon by examining relationships between variables. It is used in physical sciences and originated from the scientific process although it is used within studies involving research with humans (Johnson and Christensen, 2014, p. 33). Furthermore, the quantitative approach is a systematic and objective method in which data are explained and measured using for example descriptive figures and numerical data to produce findings, and these are then tested and examined in relation to a cause-effect relationship (Creswell, 2013). The quantitative approach is considered to use more

objective measures than the qualitative approach which relies on subjectivity (Donyai, 2012, p. 43). Using a quantitative approach, the researcher is tasked with providing an objective view to understand the facts by using methods that do not require any direct interaction with participants e.g. surveys that are self-completed rather than in-depth interviews (Denscombe, 2014, p. 166). Another example of the quantitative approach is the direct observation when it involves taking objective measurement of a phenomenon for example using a data collection form (Bernard, 2011, p. 306). Observation is one of the standardised ways in which data is collected when it can be assured that an accurate and objective recording can be made by a researcher who acts in an impartial way (Donyai, 2012). In this study, quantitative data was collected using the direct observation method used by others for measuring MAEs, by shadowing the nurses. This is a well-established method of data collection in this field which was first described by two pharmacists (Barker and McConnell, 1962 as cited by Barker et al., 2002a).

2.2.2.1 Observation method

The observation method is defined as "the systematic description of events, behaviours, and artefacts in the social setting chosen for study" (Marshall and Rossman, 2011, p. 139). According to Kawulich (2005), this method is useful in research studies in several ways. For instance, it provides methods to identify participants' emotional expression, communication with others, interaction, and noting the amount of time spent on different activities. Also, it can collect information and data of what actually happens in real practice. The observational method can be applied to collect qualitative data by watching behaviour or causal aspects in the natural setting (Taylor-Powell and Steele, 1996). It can also be applied to collect quantitative data relating to measuring the incidence of a specific phenomenon happening in practice or by developing a correlation to a measured variable (Coolican, 2014, p. 139). This method is used in the

study of an organisation and delivery of care, such as healthcare settings where it is useful to reveal what happens in the study of daily work, for example in hospital wards (Pope et al., 2002).

The structured observation method aims to produce accurate quantitative data on particular pre-specified observable behaviours or patterns of interaction (Coolican, 2014, p. 140). It is a technique in which the observer produces accurate rules (schedule) for the observation. Also, it entails the direct recording of behaviour in terms of categories that have been devised prior to the start of the data collection (Bryman, 2012, p. 272). It is also worth mentioning that quantitative data collection through observation is normally through non-participant observation, which is used to define a situation where the researcher observes, however, not to participate in what is happening in the setting (Bryman, 2012, p. 273).

In addition, there are two types of observation; disguised and undisguised observation. The disguised observation is where the participant is not aware that he/she is being observed by the researcher. However, in the undisguised observation, the participants know that they being observed (Jackson, 2015). In this research study, the nurses were informed that they will be observed by the researcher (undisguised observation), in agreement with the ward managers as part of the Trust approval. This method has been used in a number of MAEs studies (Taxis et al., 1999, Barker et al., 2002, Tissot et al., 2003, Chua et al., 2010).

2.2.2.2 Advantage and disadvantage of the observation method

Like any other study method there are some advantages and disadvantages of the observational method. One of the advantages is collecting data where and when an event or activity is occurring in the setting. Another advantage is that observation does

not rely on people's willingness or ability to provide information. Also, observation allows the researcher to potentially directly see what people do and feel (Coolican, 2014, p. 140). Disadvantages include that observation can be very time-consuming compared to other data collection methods, and does not always increase the understanding of the reasons behind people's behaviour. Also, it is liable to observer bias and that the people's behaviour can be affected e.g. (usually perform better when they know they are being observed) (Coolican, 2014, p. 140). Dean and Barber (2001) considered the potential effect of the research on the participants who are being observed and associated this with the validity of observational data. Staff might behave in a different way when they know that they are being watched or observed. The MAEs rate could decrease if nurses are more careful while the researcher is observing; in contrast, the error rate might increase if the researcher is interrupted and the nurses will become worried. This phenomenon is sometimes called the 'Hawthorne effect' (Campbell et al., 1995). However, observing nurses in drug administration round does not appear to affect the MAE rate (Dean and Barber, 2001). In addition, observation methods are considered to be the most reliable data collection method that capture MAEs (Barker et al., 2002b).

2.2.3 Qualitative approach

The qualitative approach is a naturalistic approach that aims to study things in their natural settings as well as attempting to make sense of or understand phenomena in terms of how people make sense of the world. Moreover, in the qualitative approach the researcher is usually involved to study data in an attempt to understand particular experiences of phenomena from the participants' point of view (Lincoln and Guba, 1985, Denzin and Lincoln, 2013). Having said that, qualitative research is a wide

approach to understand social phenomena which requires an understanding of different data collection and interpretation strategies (Creswell, 2013). Qualitative data includes a range of data collection methods such as; participants' observation (fieldwork), interviews and focus group. Also, the creation of pharmacy-related qualitative data could contain ethnographic methods and discourse analysis of text (Donyai, 2012). Marshall and Rossman (2011) state that qualitative research is suitable when the study needs deep understanding of the participants' experiences, hidden beliefs, and to hear their silenced voices. Also, qualitative research could be very useful to understand participants' difficult circumstances including cultures instead of testing a hypothesis or cause-effect relationship (Savin-Baden and Major, 2013).

2.2.3.1 Ethnographic research

Ethnographic research takes place in a culture-sharing environment where the researcher studies and tries to understand the consequences of a group of people's behaviours, interactions, values, and perceptions (Creswell and Poth, 2017). Thus, ethnographic research commonly involves the observational methods to allow an in-depth understanding of cultural practices. Also, it involves a long-term engagement in fieldwork that the researcher integrates with other interactions with participants for data collection through the qualitative method such as participation, observation or interviews, which all increase the credibility of the work (Gobo, 2008). The purpose of ethnographic research is mainly to recognise and understand the changes to the organisation culture and social group (Creswell and Poth, 2017). In addition, ethnographic research has been used in studies looking at medication errors by using observational methods (Taxis and Barber, 2003b).

2.2.3.2 Semi-structured interviews

The interview method as a qualitative approach is commonly used in healthcare setting research (Pope et al., 2002). Interviews are basically a series of conversations between the researcher and the participants. On the other hand, interviews could have some limitations, where the interviewees can be reluctant to share some information that the researcher expects to identify, as well as if only a small number of interviews are conducted the findings cannot be generalised (Boyce and Neale, 2006). Interview questions can help to extract responses from participants, but they must generally be worded carefully in order to avoid leading the interviewees in their answers. Hence, interview questions are commonly open-ended, neutral, and clear (Patton, 2002). There are three types of interview methods: structured, semi-structured, and un-structured interviews (Holloway and Galvin, 2016, pp. 89-91). In the current research, semi-structured interviews were conducted with nurses and pharmacists. This type merges features of the structured and un-structured interviews DiCicco-Bloom and Crabtree (2006), allowing a more flexible and less formal situation where the researcher can ask open-ended questions and it allows the interviewee to express their opinions and beliefs freely (Pope et al., 2002).

2.2.4 Mixed-method approach

According to Creswell and Clark (2007), a mixed-method study is defined as a "methodology which involves the philosophical assumptions that guide the direction of the data collection and analysis and the mixture of qualitative and quantitative approaches in many phases in the research process". A mixed-method approach involves collecting both quantitative and qualitative data for a specific purpose, usually to bring additional meaning that cannot be gained from following one methodological approach on its own (Creswell, 2013, p. 11). Moreover, Davis and Hughes (2014), state

that quantitative and qualitative approaches have advantages and disadvantages. Besides both being different in style, language and objectives, these approaches depend on the researcher skills, training and experience (Davies and Hughes, 2014, pp. 9-10). Nonetheless, a mixed-method approach can increase the validity of the study findings, deliver better data collection and enrich understanding of research results (Tashakkori and Teddlie, 2010). As the mixed-method approach has been narrowly applied in medication errors e.g. (Tang et al., 2007, Alomari et al., 2017), further mixed-methods research is needed to present the whole picture about MAEs in practice. Overall, the use of a mixed-method approach within a single study has been supported by many researchers, which seek to triangulate quantitative data with qualitative data (Jick, 1979, Johnson et al., 2007).

2.2.5 The approach adopted in this study

Qualitative and quantitative approaches can legitimately be used in combination with each other (Sandelowski, 2000, Morse, 2003, Creswell, 2013). In this study, a mixed-methods approach was adopted by collecting, analysing, and combining both quantitative and qualitative data to provide appropriate answers to the research aim. For example, the rate of MAEs from the quantitative method and the cause of MAEs is from the qualitative method could be examined together. At the same time this approach draws on the strengths and minimising the weaknesses of each research approach to strengthen the overall validity of the findings. These mixed-methods were used to clarify differences and similarities, and to triangulate the data as a means of understanding and achieving the study objectives. For example, the causes and contributing factors of MAEs from researcher observation, nurses and pharmacists opinion could be brought together.

The use of more than one approach in a research study amounts to a form of 'triangulation' which can enhance confidence in the findings of the research (Johnson et al., 2007). As a result, both direct observation and interviews were included, with the logic of induction and deduction being applied during the interviews and the observation. This is one rationale for adopting a mixed-method approach. Another was to help increase understanding, overcome bias, and verify the overall meaning of data (Golafshani, 2003, Tashakkori and Teddlie, 2010).

2.3 Study setting

This study was completed at BHFT which as previously described is a mental-health and community hospital Trust in the UK. The quantitative work involving the observation of the medication administration round was completed with all 19 wards at the Trust; 9 community hospital wards (CHWs) and 10 psychiatric wards (PWs) starting from 6th July 2015 to 15th October 2015. The interviews were conducted in 2016-2017 with a total of 12 participants (eight nurses and four pharmacists).

2.3.1 Descriptive explanation of ward practices

The following is a description of the normal practice on wards at BHFT, together with areas in which variations occur.

2.3.1.1 Medication administration by nurses

Four drug rounds normally take place on each ward on each day with scheduled times of 08:00, 12:00, 18:00 and 22:00; some wards start the morning and evening rounds at 07:30 instead of 08:00, 17:00 instead of 18:00. These earlier starts are to accommodate for situations when there are patients need multiple medication, thus requiring more time for the round. The qualified administering nurse signs the paper medication chart each time a medication is administered to the patient. There is an omission code to be

used when the nurse cannot administer the medication for any reasons e.g. 'R' if the patient refuses the medication. During each administration round, the drug chart is picked up and each medication order scanned by the nurse to see if a dose is due for that patient on that round. The nurse then prepares and administers the medication to the patient (see Appendix 1). There are three main ways for drug administration at BHFT: administration from a drug trolley (community hospital wards), administration from bedside-patient lockers (community hospital wards), and administration from the clinic room (psychiatric wards). The medication administration on each ward is undertaken by one or two nurses at the same time depending on the wards.

Wards administering medication from drug trolleys

In most of the community hospital wards that use the trolley for administration, where the ward is large, the round is split into two administration rounds with two trolleys being used at the same time to serve each side of the ward. It is normal practice that each section has one nurse in charge of administering medication to the patients. The trolley always stays locked in the nurse station. At the beginning of each round the items in the drug trolleys are refilled from the ward 'stock cupboard'. Non-stock items are dispensed from the pharmacy department when required and ward staff collect from pharmacy. During the medication administration round, the nurse releases and unlocks the drug trolley from the wall and moves the trolley from bedside to bedside as part of the process. The drug administration round starts in sequence from one end of the ward focusing on one patient and ends with the last patient on the ward. If the stock item is not found in the drug trolley, the nurse gets the drug from the stock cupboard taking care to lock the drug trolley.

Wards administering medication from bedside-patient lockers

In the community hospital wards which use patient lockers for medication administration, there are two types of patient rooms; single-bed rooms, and multi-bed rooms which are divided into bays and beds. Again where relevant two half drug rounds take place at the same time with one nurse is in charge of each half. The medication administration process is similar to the drug trolley wards mentioned above, however the only difference is that the medications are administered directly from the bedside locker instead of the drug trolley. Sometimes the nurses use the drug trolley to administer stock items which are not available in the patient locker, or when the large bottles of medication cannot fit into the locker. The medication supply for these lockers is directly dispensed from the pharmacy department or from the POD. Also, these medications are a combination of inpatient and one-stop dispensing for a 28-day supply, fully labelled with directions for when the patient is ready to leave the hospital.

Wards administering medication from clinic rooms

In most of the psychiatric wards only one nurse is in charge of medication administration, and in some larger wards two nurses are in charge of administering medication to patients from the clinic room. The administration on these wards takes place directly from the 'stock cupboard' or a locked drug trolley within the clinic room. At the beginning of each round when the medication is administered from the clinic room, the nurse responsible for the medication administration round firstly checks all of the drug charts on the ward. This is in order to identify patients due medication during that actual round. Once identified, these patients are called to wait outside the clinic room in order that their medication is prepared and given to them. This mode of administration is sometimes known as 'queuing' to describe this process based on what

the patients are in affect asked to do. In some large wards which involve elderly patients with special conditions such as dementia, the nurse prepares their medications in the clinic room and then gives them to the patient one by one in their rooms, taking care to lock the clinic room each time. The following Table 2.3 shows the mode of administration used in BHFT wards.

Table 2.3: The mode of administration used in BHFT wards

Where given	Where prepared	Where administered
Bedside-	Clinic room	PWs
	Trolley	CHWs
	Patient lockers	CHWs
Inside clinic room-	Clinic room	PWs

2.3.1.2 The drug chart as a record of drug prescribing and administration

The medication prescribing and administration in this setting are recorded on paper drug charts. At BHFT, there are two different drug charts, one for the PWs and one for CHWs which are similar. The drug chart used is a piece of card folded once to make two A4 segments and four A4 sides for recording information. The first section of the chart includes patient details, any allergies and is reserved for prescribing of the stat (immediate) doses and regular long-acting injectable medicines in mental health. The other three sections are for prescribing and recording administration of other medication; two of these prescribing sections for regular prescriptions. And the last section for ‘as required’ prescriptions also known as PRN as well as for prescribing leave medication for preparation by the pharmacy. Occasionally, in PWs drug charts

there is also alcohol detox chart attached. Some wards also use warfarin charts where they record the International Normalised Ratio (INR) and the doctor prescribes on a daily / frequent basis according to the INR. The drug chart for each patient is placed either at the end of their bed, outside of their single room, held in the nurse station, or kept in the clinic room. All medications are prescribed on the paper drug chart by the medical staff. The nurses refer to each drug chart in order to administer medications at each of the four regular drug rounds. The nurses then record and sign the administration of each dose on the patient's chart in the appropriate section or code this if omitted. Each regular medication prescribed on the drug chart allows administration or non-administration to be recorded for an eight-week period only.

2.4 Data collection

This research study as mentioned before employed the mixed-methods approach, and the data was collected using the techniques of observations and semi-structured interviews which will be explained in more details below. However, types of MAEs and some definitions are important to be considered before explaining the data collection process. An MAE is defined as "any dose of medication administered (or omitted) that deviated from the written medication order" (Allan and Barker, 1990). The observation data recorded all the different types of medication administration errors including Omission (O), Allergy Error (AE), Extra Dose(s) (EDs), Wrong Dose (WD), Un-prescribed Drug (UD), Drug Incorrect (DI), Formulation Error (FE), Route Error (RE), Deteriorated Drug (DD), Wrong Time Error (WTE), Other, and Linked Error (e.g. linked to dispensing error) (see Table 2.4) (Barber et al., 2009). Table 2.4 was critical to this study because it formed the basis of the error data collection. Note, if doses were left by the patient's bedside, these could also be considered as MAEs.

Table 2.4: Types of medication administration error (Barber et al., 2009)

Type of errors	**Definitions**
Omission (O)	A dose of medication that has not been administered by the time of the next scheduled dose. Does not include doses omitted according to doctor's instructions, nurse's clinical judgement, if patient refuses or if patient not on ward.
Allergy Error (AE)	Administration of a drug for which the patient has a known drug allergy
Extra Dose(s) (EDs)	The administration of an additional dose of a prescribed medication. Includes administration of a drug more times in the day than prescribed and administration of a dose of drug after it has been crossed off the drug chart.
Wrong Dose (WD)	The administration of the correct drug by the correct route but in a quantity that was not prescribed. Includes administering inhaled steroid without spacer when one is available; administration of incorrect number of dose units; failure to shake a bottle of suspension prior to administration; measurement of an incorrect volume of an oral liquid. Where liquid preparations are not measured correctly or poured into non-graduated medicines cups, a wrong dose error has occurred only when the observer is certain that the wrong volume has been administered. If wrong strength is given because of a dispensing error this is still an MAE.
Unprescribed Drug (UD)	The administration of a drug that was not prescribed for the patient concerned (classified as a "drug incorrect" error if drug X prescribed but drug Y given instead). This may occur if medication had been stopped by the prescriber but was not removed from drug trolley.
Drug Incorrect (DI)	A dose of a drug administered that is not the drug prescribed. This could occur if administration followed an undetected dispensing error and would be a linked error.
Formulation Error (FE)	The administration of the correct dose of the drug by the correct route but in a formulation that was not prescribed. Includes administration of a modified release when non-modified prescribed, and vice versa. This may be linked to a dispensing error if the wrong form was dispensed. It also includes modification of the dose where not authorised, e.g. crushing tablets or opening capsules.
Route Error (RE)	The administration of the correct drug by a route or site which was not that prescribed.
Deteriorated Drug (DD)	Administration of a drug that has exceeded its expiry date or a drug with its physical or chemical integrity compromised, where none of above error types occurred. N.B. Note that multi-compartment compliance aids have a shelf life of 8 weeks from date of dispensing and are sometimes prepacked and if so should have an additional label (probably out of sight) which has batch number, original expiry date and date of dispensing.
Wrong Time Error (WTE)	All timing errors will be recorded regardless of whether the timing of the administration could have clinical significance
Other	Use to record anything that is not covered above
Linked Error	Use to record the MAE if linked to another error e.g. dispensing error

In relation to the Deteriorated Drug (DD) type of error, some medications such as liquid medication, eye drops and insulin, should be labelled showing the date of opening and expiry, according to the BHFT policy. In addition, when the medications did not have a label showing the opening and expiry date, the researcher called this type an 'expiry error' in the current research study. The other error which named by the researcher 'other reason errors' is included anything that is not covered above. In this study it included only the failure to following the hospital procedure or other counselling guidance when administering the medication. For example, not dissolve dispersible tablets prior to administration, not telling the patient to disperse orodispersible tablets in the mouth before swallowing directly, and not directing the patient to rinse their mouth straight after use of corticosteroid inhalers etc. Furthermore, a WTE was counted when medication was administered before or after two hours from the time prescribed on the drug chart as stated in NPSA guidance (NPSA, 2010). This is also in line with BHFT SOP around administration of critical medicines, where two hours is the set limit (see Appendix 2).

2.4.1 Sample size and recruitment

For the quantitative data collection (through direct observation), the purposive sampling method was used whereby all of the four medication administration time points on every ward at the BHFT was observed at least once to obtain some equality across the wards. In addition, the researcher observed each ward medication round only once due to the total number of wards and the potential limitation of the observation logistic time plan. A total of 65 observations were made by the researcher covering all 19 of the BHFT wards. In total 35 of the 65 observations were of psychiatric wards and 30 of community hospital wards.

There were two categories of interviewees in this study, namely nurses and pharmacists. A total of 12 semi-structured interviews were conducted face-to-face with eight nurses (three working on community hospital wards, three psychiatric wards and two lead nurses) and four pharmacists. The interviews were conducted and analysed at the same time, so that sampling could stop at a stage when data did not generate any new information on the issue under investigation; which is known as 'data saturation' in qualitative research (Glaser and Strauss, 1967 as cited by Francis et al., 2010).

It was planned to interview one nurse from each ward, with a total of 19 nurses being contacted through their wards manager via an email. Six nurses agreed to participate. After interviewing these six nurses, it was felt that the information was repetitive and no new perceptions were identified. However, to ensure the validity of the data, two more nurse interviews were conducted. As a result, the interviews were stopped at 8 nurses when no new data emerged from the participants. It was possible to conduct interviews with four suitable clinical pharmacists to gain more information about MAEs from other healthcare professionals related to medication administration and compare their perceptions with that of nurses. Moreover, the reason for interviewing the pharmacists in this current study is that they routinely looking at drug charts, and that the medication administration is one of the pharmacy departmental interests e.g. (blank box audits).

The nurses and pharmacists were recruited from the BHFT after they replied to a letter of information passed on via a secondary source (Mrs Kate Masters who is an external co-supervisor to the research student). All participants received an information sheet that included a full description of the study, and they had a choice to decide whether they wished to participate in the study or not (see Section 2.5.4). For observations of

medication administration rounds, a suitable rota was constructed (see Appendix 3) to allow observation of appropriate staff who had consented to take part. Prior to each observation or interview, written consent was obtained from the participants. All interviews were conducted face-to-face in a private room at a workplace building (e.g. in a meeting room at BHFT).

2.4.2 Quantitative data collection

Before starting to collect the data, the researcher was trained for 3-month duration (6-8 hours a week) in the pharmacy department at BHFT, in order to be familiarised with the medication management systems at the Trust. This involved shadowing medicines management technicians on all wards as well as dispensary. Also, the researcher took a training session on medication administration observation with an expert pharmacist (Mr. Alan Cottney) at the East London NHS Foundation Trust in London. The session was one working day duration including explanation of the drug chart sections, the administration round process at the Trust and training on how to observe the nurse during the drug administration round. This training session was very important; Mr. Cottney has considerable experience in the observation on medication administration errors. Also, Mr Cottney is well-known for his work in mental-health wards as a research area as he has published a number of relevant studies.

2.4.2.1 Pilot study

A pilot study took place at one of the wards at the noon medication administration round, by shadowing the nurse with the aim to assess the usability of the data collection form process (whether it was applicable to the study or not). The pilot study allowed the researcher to familiarise themselves with the procedure of the medication

administration round. The pilot form was found to be acceptable and no major changes were made.

2.4.2.2 Direct observation of medication administration rounds

The researcher used a cross-sectional prospective direct observation method. Ward managers were familiar with the project a month earlier, to discuss the study and encourage nursing staff to participate, to examine the proposed visit days, and to communicate all information to nurses on duty during the visits. The study was approved and endorsed by the Director of Nursing at BHFT encouraging wards to participate.

Medication administration rounds for regular and 'as required' (PRN) drugs were observed by shadowing the nurses and making notes discretely using a data collection form (see Appendix 4). The form illustrated the data that were collected, which included start and finish times for each drug administration round observed as well as a multitude of other factors relating to medication errors and potential contributing factors.

Moreover, the researcher visited each ward at the Trust at least twice on different days, and on every visit one medication administration rounds was observed (e.g. morning or lunchtime). In some large wards where the drug administration rounds splits into two different ends, the researcher observed only one of these split rounds. Any doses administered between the medications rounds were not considered as OEs because it is was not possible for these to be observed. Normally OE is counted as any dose of medication that is observed either as being administered or omitted, which could be classified as being either correct or incorrect (Taxis and Barber, 2003a). In this thesis, each OE was associated with no error, one error or with more than one error.

Before the start of the medication administration round, the researcher arrived around 2 hours earlier to check the drug charts and the medication cabinets. Accordingly, the due medication for each patient was recorded in the data collection form. Then, the researcher introduced himself to the nurse in charge of the medication administration round, and when the nurse started the administration round; the researcher shadowed the nurse and watched every given dose to the patient carefully. After that, if any error occurred, the researcher manually reordered this error by ticking the boxes for the error type in the data collection form. The data were transferred from the paper data collection forms to a Microsoft Excel spreadsheet which was double-checked by the researcher and another PhD student at the University of Reading.

2.4.3 Qualitative data collection

Two qualitative data collection techniques were applied in this research. Firstly, detailed observational notes were made by the researcher, in addition to the quantitative data collection, when making the observations on each ward. In addition, there were semi-structured interviews with nurses and pharmacists which were transcribed and the data analysed qualitatively. The aim of the qualitative analysis as a whole was to gain perspectives on the potential contributing factors leading to the key errors found through the observations. As well as categorising the 'active failure' category for each error, the qualitative work aimed to explore the wider work-related and organisational reasons behind MAE occurrences.

2.4.3.1 Observational notes

On each visit the researcher took notes about the ward setting (e.g. the environment), then, when the nurse started the administration round, the researcher recorded different contributory factors in the data collection form such as whether the nurse was

interrupted during administering the medications, or whether the ward was busy with another activity or not, the mode of administration used in the ward and any other contributing factor relating to MAEs. During the same time, notes were taken about every potential error in a note book, including the ward name, date, time and number of observation. Also, when the errors occurred, the researcher recorded the nurse's behaviours or actions on administration e.g. nurse not give the medication deliberately or forget to give the medication, and if these changes related to any contributing factors. This helped to reflect more in-depth about the reasons and the contributory factors relating to these errors. There are no specific guidelines criteria or templates have been followed to record MAEs type and contributing factors. However, the researcher drew the MAEs type from one paper (Barber et al., 2009) and the idea of contributing factors from another (Cottney and Innes, 2015) which have been piloted as mentioned above (see Section 2.4.2.1). Moreover, there was sometimes conversation between the researcher and the nurse during the observation regarding some of the medication administration errors found; this was mostly instigated by the researcher. The conversation outcome gave the researcher greater confidence to justify the reasons behind those errors especially if nurses did not comply with the rules. Then further descriptive notes were made in relation to the observations. These notes focused on the context and explanations about how and why the errors happened. In this sense, the qualitative element of the work was in the spirit of ethnographic research described earlier.

2.4.3.2 Semi-structured interviews

Semi-structured interviews in this study were conducted with a total of 12 participants; eight nurses (three from community hospital wards, three psychiatric wards and two lead nurses) and four pharmacists. These were completed face-to-face, privately in a

meeting room at BHFT. In addition, all the interviews were audio-recorded with a digital audio-recorder and participants were asked for permissions to record the interviews for a more comprehensive data analysis. The interviews were kept confidential and used only for the purposes of this research study.

The interviews were based on a very detailed and thorough interview schedule relating to the medication administration errors found during the observation period. During the interview, the researcher asked each participant to answer questions on their experiences and opinions about the reasons behind the MAEs (see Appendix 5). These recordings were stored on a memory stick in a locked cabinet accessible only by the researcher and his supervisor. Then, these recordings were transcribed by a transcription agency which is approved by the University of Reading; these transcripts were saved onto Microsoft Office Word documents. Finally, the researcher double-checked the transcripts against the recordings and deleted any names or other information that might identify the interviewees. At the end of this study the digital recordings were deleted.

2.5 Ethical issues

This research primarily involves healthcare professionals working in BHFT who are involved in the medication administration or related processes on all wards. For this reason, the study received ethical approvals from the University of Reading's Research Ethics Committee and ethical approval was not required by the BHFT Clinical Audit department, only an approval to run a service evaluation (see Appendix 6). The overall research risk was outlined and considered to be low. The potential risks for both types of research (quantitative and qualitative) together with risk management strategies are outlined in Table 2.5 and Table 2.6 below.

Table 2.5: Observation of nurses conducting medication administration rounds on wards

Potential Issue	**Description of problem**	**Risk management processes**
Anxiety or distress of being observed	Participants may become anxious or distressed by the researcher observing their practice.	Act professionally during observations and work with minimal intrusion so as to not provoke anxiety or distress in individuals. If individuals may become anxious or distressed they can ask for the observation to be halted / terminated. The information letter for the medication administration observations will state that individuals do not need to participate in the observation of their round if they do not wish to. The Information letter will explain the research and its intention as well as how they can withdraw from the study if they wish.
Exploitation and undue pressure to participate	Participants may feel pressurised into participating in research. Participants may make a mistake that is observed and noted and this may make them feel vulnerable.	Participants will be formally invited via letter. They will be contacted via the ward manager and the pharmacist contact. If participants do not wish to take part, they will not be pressurised into doing so. The invitation letter will explain the research and its intention as well as the fact that all observations will be recorded according to date and time of ward round rather than recording any nurse details. If any medication administration errors are observed they will be dealt with according to the description in the next row.
Risk of poor practice being identified and misrepresented	Participants' mistakes may be misrepresented or taken out of context by being reported to ward manager without their knowledge.	Any medication administration error that is observed will be noted on the data collection sheet in the first place. The researcher making the observations is a pharmacist and will make a judgement about whether or not to intervene in the case of a potentially serious error (see next row). Otherwise, all data on medication administration errors will be collated and fed back anonymously to all staff concerned after the data collection periods so that general lessons can be learnt from the nature of mistakes made.

Potential Issue	Description of problem	Risk management processes
Risk of potential harm to patient from a medication administration error	Patients may be harmed if the researcher notices a medication administration error and does not intervene to alert the nurse making the error.	The researcher making the observations will be trained to identify potential errors and briefed on the importance of stepping in, if necessary, in order to protect the patient. If such an issue arises, the researcher will check the details of the drug and the dose with the nurse before it is administered to the patient. If the nurse does not recognise or agree with the potential for error the researcher will ask to speak to the nurse, away from the patient and any nurse taking part in observations will be made aware of the fact that this is part of the remit of the researcher without wanting to apportion any blame. The nurse involved will be encouraged to report such an event as a near-miss error using the normal error recording processes.
Risk of harm to researcher	Researcher may be placed in an uncomfortable position when observing errors and communicating errors to nurses doing drug rounds if they do not receive the cooperation of the nurse when a potential error is identified.	The researcher making the observations will be trained to use appropriate communication skills when speaking with nurses, using a stepped process. They will ask the nurse if they can speak privately to them away from the patient; the researcher will be trained to speak with confidence to clearly state their thoughts about a potential error without attribution of blame. If the nurse does not acknowledge the potential for an error or does not cooperate, the next step would be for the researcher to abandon the observation and seek the assistance of either the pharmacist contact or the academic supervisor. The researcher will therefore not be put in an awkward situation that necessitates continuing with the observation.
Risk of harm to researcher	Researcher may see and hear situations in the mental health ward that could be upsetting when observing a drug round. Researcher may encounter patients who may be depressed or distressed or aggressive towards hospital staff and/or the researcher.	The researcher will be trained to recognise and remove himself/herself from potentially dangerous situations. Regular debrief sessions will be held so that the researcher collecting data can talk about and share experiences with the pharmacist contact and academic supervisors.

Potential Issue	Description of problem	Risk management processes
Anxiety or distress by patients with the researcher to present	Patients may become anxious or distressed by the researcher observing the practice.	The researcher will not observe the drug for this patient.

Table 2.6: Interviews with nurses and pharmacists

Potential Issue	Description of problem	Risk management processes
Consent provided to participate in interviews	Participation in interviews may be deemed not to be voluntary. Participants may feel that they must take part in interviews.	Participants will be formally invited via a letter. They will be contacted again for follow up. If no response, no further contact. The letter will explain this element of the research and its intention as well as how they can access the final data before any publication.
Content of interview questions	Participants feel that the questions are not appropriate or they do not want to answer the questions posed due to the nature of the questions.	If possible the interview schedule will be piloted with a small group of health professionals outside the study ward to ensure that the questions are being interpreted correctly and that they are appropriate.
Anonymisation of information provided by nurses	Participants do not want to be identified in results.	The interview transcripts will be stored without including the identification of the persons who was interviewed.

2.5.1 Steps taken to ensure ethical practice

The following were made clear in the information sheets provided to the participants.

1. Taking part in this research was voluntary and the participants all had the right to withdraw their consent to participate at any time before, during or after the study without any penalty or repercussions.

2. In terms of any interviews, the participants had the right not to answer any question that causes any disturbance to them and the researcher. In addition, unnecessary questions which could provoke anxiety or distress in individuals will be avoided. If individuals become anxious or distressed they can stop discussing the topic.

3. Confidentiality and privacy was ensured for all participants and the information gathered only used for research purposes.

4. All participants were provided with a consent form and information sheet (which included a detailed description of the nature of the study, why the research was being conducted, why they had been chosen to participate, and the nature of the questions that would be asked), and that the researcher would answer any question before the consent forms were formally signed. As well as that, all the participants had at least 24 hours to decide whether they wished to participate or not.

5. A written consent form was obtained from all participants before each observation/interview which informed them of their right to withdraw from the study at any point.

6. Participants were asked for their permission to record observation or audio-record any interviews. The researcher used a digital audio-recorder to record the interviews. The recordings were stored on a memory stick in a locked cabinet accessible only by

the researcher and his supervisor. Afterwards, transcripts were made from these records onto Microsoft Word documents without containing any names or information that might identify the participants. At the conclusion of the study the digital recordings will be deleted.

7. Records of observations and transcripts that were made from the interview recording contained no names or other details that might identify the participant. Instead non-identifiable codes were used and other identifiable information altered.

8. To minimise misrepresentation, participants were provided with a copy of their interview transcript if requested and the researcher also offered to feedback the analysis to them before the findings are published.

9. To avoid identification of participant by others by quotes in published research all information is anonymised to prevent association of participants to defined quotes. Non-identifiable codes were used and other identifiable information was altered.

2.5.1.1 Handling of patients

Before each patient received their medication, the nurse explained to the patient that a PhD researcher would be observing the nurse's practice (and not the patient). If the patient showed signs of anxiety or distress or indeed disapproval then the researcher did not observe the medication administration for this patient. In addition, the researcher placed a notice on the ward explaining their presence for the purpose of observing medication administration on the ward when he was present (see Appendix 7). If there were any unsuitable or 'at risk' patients present on the ward, then the researcher took advice from the nurses about what to do – for example, whether to cancel the session altogether or to take steps to exclude dealings with the relevant patient.

The PhD researcher also wore a Pinpoint staff personal attack (PIT) alarm whilst on the wards which is easily activated in an emergency.

2.5.1.2 Conversation with nurses about potential medication administration errors

A participant information leaflet relating to the observations was passed on to all nurses before they were asked to consider consenting to take part in the observational study. These detailed how the researcher would interact with them if he thought that an error had been identified. Although it is quite possible that some errors might not potentially cause any patient harm (e.g. vitamin tablet given in the morning instead of lunchtime) and could be recorded by the researcher and then reported back after data collection, the more likely scenario was envisaged to be for the researcher to encounter a potential error that had the possibility of causing patient harm. In this case, it was important for the researcher to speak with the nurse being observed as soon as they suspected a potential error in terms of the medication selected by the nurse for administration to the patient (i.e. before it was given to the patient).

The researcher did that by asking the nurse if they could please read out what the prescribed medication is (drug, dose and time of administration) to check their (the researcher's) understanding of the prescription. If the researcher still believed that the wrong product may have been selected, and it did not become apparent to the nurse that, in the opinion of the researcher, there appeared to be a discrepancy between what they had selected for administration and what had been prescribed, then the researcher asked to speak with the nurse away from the patient to discuss with them that there may be a potential administration error. Clearly, identifying an error and having a conversation with the nurse about it, had the potential to impact on the rapport between

the researcher and the nurse, but as explained in the information leaflet and consent form, the nurse had the right to end the observation at any point.

2.5.2 Payment

No money or payment otherwise was offered to nurses who were being observed during the normal medication administration rounds. Nurses and pharmacists taking part in interviews were offered a £10 Amazon vouchers if they agreed to participate in the study. The researcher took the decision to offer this amount based on the inconvenience participants face, as busy professionals, in giving up their lunch hour or other free time to participate in the research and it was believed, and agreed by the Ethics Review Committee, that this was reasonable to achieve the recruitment required.

2.5.3 Data protection and confidentiality

Confidentiality and privacy was ensured for all participants and the information gathered was only used for the scientific purpose of this study. Participants were asked for their permission to record observations of medication administration rounds or to record the interviews. The researcher used a digital audio-recorder to record the interviews. One copy of the recordings was stored on a memory stick in a locked cabinet in a secure office accessible only to the researcher and his supervisor. For the purpose of transcribing, a copy of the files was directed through a secure website to the transcription agency (which is a university-approved supplier of secure transcription services). Afterwards, transcripts were made from these records on Microsoft Office Word documents without containing any names or any information that might identify the participants. All the information was anonymised to prevent association of interviewees to defined quotes or specific individuals to mistakes made. As well as that,

non-identifiable codes were used throughout when coding for interviews. At the end of the study the audio-taped records will be deleted.

2.5.4 Consent

All participants received a pack that included an information sheet (inviting them to take part in the study and giving them full information about the study) (see Appendix 8) and a consent form (see Appendix 9). The researcher worked with the ward manager to identify suitable timeslots for each week when the medication administration rounds were observed. By looking at the staff rota in advance and speaking with duty nurses, it was hoped that a sufficient number of nurses would consent to be observed, therefore, a letter was sent to wards managers to encourage their nurses to be involved in the study without undue coercion (see Appendix 10).

In terms of the interviews, when an initial interest had been shown, the time and location of the interview was identified and agreed. For the interviews, the researcher explained verbally prior to each interview the study again to ensure that the participants understood everything in the information sheet. In addition, the researcher explained to all participants their rights to withdraw from the study at any point without any penalty and not to answer any question that caused any disturbance to them. All questions posed by potential participants (relating to the study) were answered prior to the start of the interviews. A written consent form was obtained before starting the observations, with each participant being given a copy of their signed consent form.

2.6 Data analysis

Data analysis for this research consisted of both quantitative and qualitative methods due to the data collection techniques employed; direct observation, observational notes (made by the researcher) and semi-structured interviews with nurses and pharmacists.

2.6.1 Observations: statistical data analysis (quantitative)

During the observations, a previously-devised and printed data collection observation form was used in order to record the details of MAEs. After data collection, quantitative data (observations) were analysed by employing descriptive data analysis (e.g. the number of OEs, followed by the number of MAEs and the error rates) using Microsoft Office Excel. As well as that, inferential statistics was used to determine verifiable relationships between the number of errors found and a number of potential contributing factors using IBM SPSS (version 21). Microsoft Office Excel supports different chart formats, such as bar graphs and the generation of numerical tables which can be easier to read; meaning that the data was also described by using numbers and percentages, as well as visually presented, to provide an overview and add depth to the findings. One of the distinct features of inferential statistics is that it allows the researcher to decipher whether any statically significant relationships exist. These are discussed in terms of the details of the modelling used to examine the MAEs in Chapter 3 (Section 3.3).

The medication administration errors were divided into procedural errors and clinical errors. The 'Procedural errors' is failure to follow the medication administration procedure that includes expiry errors, given but unsigned errors, and other reason errors. The 'Clinical errors' are any other errors in conduct or judgement in the clinical environment that include extra dose errors, formulation errors, almost not given errors, omitted and unsigned errors, omitted but signed, un-prescribed drug errors, wrong dose errors, and wrong time errors. In this thesis, these two types were separated to acquire more accurate results, in order to increase the quality of the data findings, whereas the combination between the two types might illustrate inaccurate findings.

In addition, after the MAEs were recorded the potential for harm from these was judged and rated by the researcher, and one of the Trust clinical pharmacists using inter-rater reliability (Haw and Cahill, 2011). The researcher gathered the 367 error cases including the notes of how those errors happened, then, the first 20 medication error cases were rated by the researcher and a copy was sent separately to the clinical pharmacist. After that, the researcher and the clinical pharmacist met to check the results and to calculate their agreement rating which was 60% matched cases and 40% was not. This might be due to different experiences of the researcher and the clinical pharmacist as some errors appeared potentially harm for one and not for the other. Differences of judgment between healthcare professionals might happen and can be resolved through discussion (Chua et al., 2010). As a result, the researcher and the pharmacist completed an analysis of harm for the rest of the 367 error cases after agreeing the rating process and discussing the differences then arranged for a second meeting to compare and agree on all the rated results.

2.6.2 Observation notes and interviews: data analysis (qualitative)

Qualitative research analysis contained three stages; first, defining the data (for example, interviews or observation), second, organising the collected data by the researcher which is also known as the coding process and the final stage which was writing the report (Miles et al., 2013).

In this study, the qualitative approach was adopted while analysing the observation notes and the transcripts of the semi-structured interviews. The researcher applied the organisational accident causation model (Taylor-Adams and Vincent, 2004) (see Figure 2.3), and the framework developed by Vincent et al. (1998) (see Table 2.1). Both are adapted from James Reason's model of organisational accidents (Reason, 1997).

The model is useful to manage the data from the observational notes and nurses and pharmacists' interview transcripts. By using this framework, the researcher started to be familiarised with the data and gain a sense to divide them into sections and classifying the data into frequent codes and categories. This was completed by highlighting a section of the data and coding with labels from the framework which were then categorised in more detail. Thematic analysis was carried out in the qualitative data where the themes form: recurrent topics, ideas or statements identified across the corpus of data. Also, the thematic analysis allows these themes to be mapped against a theoretical framework within a deductive approach.

To begin with the observational notes, the data were transcribed from the researcher's notebook to a Microsoft Office Word document, where these were divided according to the ward name that was involved where an error was found on the relevant visit (see Appendix 11).

The researcher's notes (labelled as quotes) were organised in relation to the mode of administration under each type of error; these quotes were then categorised to an active failure category i.e. slips, lapses, violations, mistakes etc. Following this, the error-producing conditions and latent conditions were categorised according to the researcher's perception in relation to the administration round and wards setting at the time. The medication administration errors were divided into procedural errors and clinical errors.

Furthermore, collected data from the semi-structured interviews for the nurses and the pharmacists were analysed in a similar way in relation to the adopted framework. The nurses' and pharmacists' quotes were organised in relation to the type of error. These quotes were classified according to the nurses and pharmacists' point of view about the

reasons behind these errors. Next, the quotes were categorised into an active failure category i.e. slips, lapses, violations, mistakes etc., followed by the error-producing condition and latent condition.

The observational notes and interviews analysis examples are provided in (Appendix 12). The codes and categories will be discussed in more detail in Chapter 4 (see Table 4.3 and Table 4.4). All data were compared and contrasted the opinions of the researcher, nurses and pharmacists about specific errors.

2.7 Summary

This chapter has described in detail the overall research design and the methodology used in this research study. Also, the methods of data collection in this thesis have been presented in relation to the literature, pointing out the advantages and disadvantages from using these methods. Subsequently, the methods of data collection were described in terms of the observational notes and semi-structured interviews. In this chapter, the qualitative, quantitative and mixed-method approaches were identified. In this study, the mixed-method approach was adopted to offer a synergistic way of examining the MAEs. Finally, the findings and analysis of the observations and interviews will be explicated and discussed in detail in the next chapters.

Chapter 3 Quantitative Findings

3.1 Findings from the ward observations

After receiving approvals from the University of Reading's Research Ethics Committee and the Trust's Clinical Audit department, the observation of medication administration rounds commenced on 6th July 2015 and continued to 15th October 2015. Nurses who administered medication during scheduled ward rounds were observed in both psychiatric and community hospital wards at the study site according to a pre-constructed ward rota (see Appendix 3). The rota had been devised to take account of different observation times (e.g. 08:00, 12:00, etc.), and days of the week to ensure an even spread across these factors. In addition, the rota had been devised such that one ward was not observed on sequential days, but rather that the observations were deliberately dispersed across the observation period for maximum variability.

During the observations, previously-devised and printed data collection forms were used in order to record the detail of MAEs that were noted and any potential contributing factors (see Appendix 4). As well as that, detailed descriptive notes were made in relation to the observations. These added further context and explanations about the setting and practices observed.

This chapter focuses on presenting the entire data in relation to the ward observations from a quantitative perspective. To provide an overview; the data recorded on the MAE observation forms were analysed quantitatively by employing descriptive as well as inferential statistics, using Microsoft Office Excel as well as SPSS (see Figure 3.1). The descriptive statistics detail, for example the total number and average of OEs, followed by the number of MAEs and the total and mean error rates. The inferential analysis,

using SPSS, examines statistically verifiable relationships between the number of errors found and number of potential contributing factors.

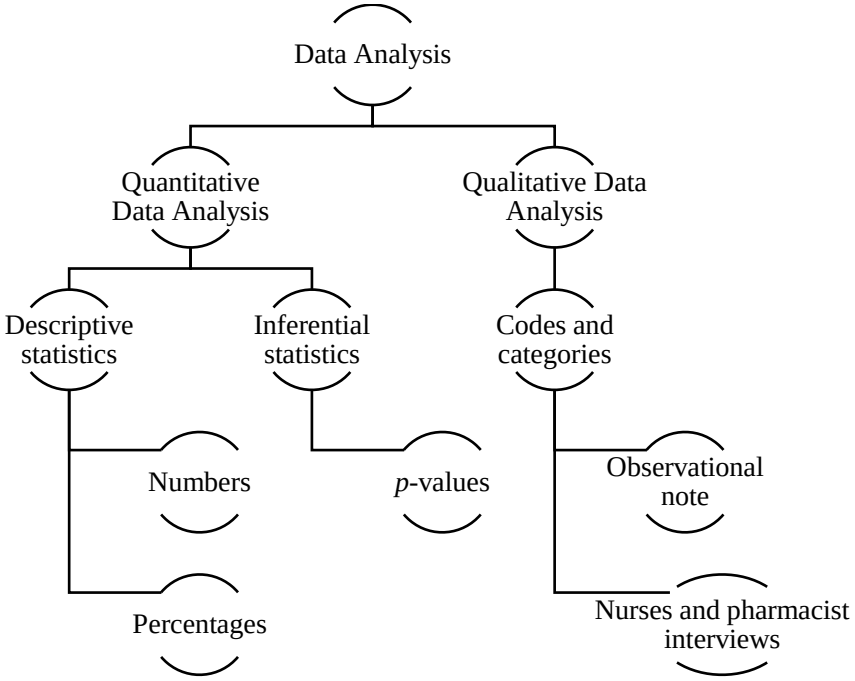

Figure 3.1: Data Analysis – an overview

3.2 Descriptive analysis of the data

A total of 65 separate observations were made by the researcher covering all 19 of the wards at the study site. Of these 65 observations, 19 were made in the morning (08:00), 16 at lunchtime (12:00), 15 in the evening (18:00) and 15 at night (22:00). From the day of the week perspective there were 14 observations on a Monday, 15 on a Tuesday, 14 on a Wednesday, 14 on a Thursday and 8 on a Friday. Over the time span of the study there were 19 observations made in July, 19 in August, 18 in September and 9 in October. Each of the 19 wards was observed at least twice with the median number of observations being 3. Thirty five of the 65 observations were in psychiatric wards and 30 in community hospital wards. Therefore it can be concluded that there was a reasonable spread of observations according to these categories.

The number of patients who received their medications during the observed administration rounds totalled 673; although some patients would have been observed more than once. Because no patient identifiers were recorded (purposefully) to keep data fully anonymised, it is not possible to know how many distinct patients were observed. In the same vein, no identifiable record of the nurses being observed was made apart from a note of their gender and work grade where (bands grade are related to permanent nurse staff, and the bank and agency status are related to non-permanent nurse staff). This was so that the performance of individual nurses could not be tracked, which was a condition of the ethical approval and detailed in the consent forms. Therefore, from a statistical standpoint, 65 different nurses were observed during the study; 42 observations (1390 OEs) were of nurse with band 5 grade, 8 observations (416 OEs) of band 6, 1 observation (46 OEs) of bank nurses and 14 observations (385 OEs) for agency nurses (Table 3.19 and Table 3.20). For band 5 nurses 12 were observed at 08:00, 10 at 12:00, 7 at 18:00 and 13 at 22:00. And, in band 6 nurses 3 were observed at 08:00, 2 at 12:00, 2 at 18:00, and 1 at 22:00. Whereas, in bank nurse 1 was observed at 18:00, and in agency nurses 4 were observed at 08:00, 4 at 12:00, 5 at 18:00, and 1 observed at 22:00.

In total, 2237 OEs were recorded and a total of 367 MAEs were observed when the WTEs were included in the MAE count, giving a total error rate of 16.4%. The number of MAEs observed when excluding WTEs was 320, giving a 14% error rate. On the other hand, when the number of errors was separated to procedural errors and clinical errors, the *clinical* error rate was 7.7%. Of the 367 MAEs, 67 were blank boxes; of these, 49 blank boxes were omitted medicines where the administration box was unsigned, and 18 were instances were medicines were given but the administration box was unsigned. The detail of the MAEs is described more fully in (Section 3.2.2).

3.2.1 The OEs observed, the MAE numbers and the error rates

Different variables of interest such as type of wards, ward round time and ward round day, etc. were considered to be best represented in relation to OEs observed, numbers of MAEs and MAE rate individually. The total MAE rate found for each category was calculated from the total OEs and the number of MAEs. However, the calculated mean (average) and the median of OEs and error rate depend on the number of observation visits as well as the standard deviation (S.D) was presented. Also, box plot and ANOVA test were used for the validity of these findings.

3.2.1.1 CHWs versus PWs

It was found that the number of OEs observed and the average OEs in community hospital wards (CHWs) were more than the number and the average of the OEs observed in psychiatric wards (PWs), however, the error rate and the mean error rate were similar across the two settings as shown in Table 3.1 and Table 3.2. This means that while there were more instances of medication given within a community ward setting, the error rate across the two settings were in fact similar as described below.

Table 3.1: The total OEs observed according to ward type as well as the number of MAEs and the error rate

Ward type	Total OEs	No. of MAEs	Total MAE rate %†
Community hospital wards (CHWs)	1249	217	17.4%
Psychiatric wards (PWs)	988	150	15.2%

†percentage error rate calculated as a percentage of total OEs for that ward type

Table 3.2: The average OEs observed, the mean error rate according to ward type as well as their standard deviation

Ward type	No. of observation visits	Average OEs[a]	S.D	Mean error rate %[b]	S.D
Community hospital wards (CHWs)	30	41.6	24.2	18%	11.2
Psychiatric wards (PWs)	35	28.2	21.4	17.8%	11.7

[a]calculated as total OEs for each visit/no. of observation visits. [b]percentage mean error rate calculated as a total percentage of error rate for each visit for that ward type/no. of observation visits

The difference in terms of the OEs is shown graphically as median values and ranges in Figure 3.2. Statistically, the number of OEs were significantly greater in CHWs compared to PWs (*p*-value <0.05) as tested using ANOVA (univariate analysis of variance) pairwise comparisons shown in Table 3.3.

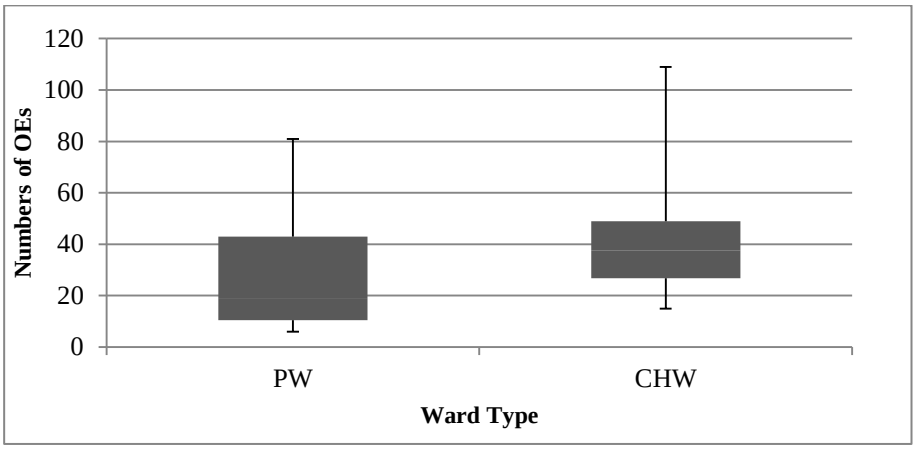

Figure 3.2: Box plot for the OEs shown against ward type.
The PWs have a median 19 OEs (range 6-81) and CHWs 37.5 OEs (range 15-109).

Table 3.3: The ANOVA pairwise comparisons for the total OEs observed at ward type
Dependent variable: OEs

(I) Ward type	(J) Ward type	Mean difference (I-J)	S.E.	*p*-value	95% CI for difference	
					Lower bound	Upper bound
CHW	PW	13.405*	5.657	**.021**	2.101	24.709
PW	CHW	-13.405*	5.657	**.021**	-24.709	-2.101

The error rates however were similar in CHWs versus PWs, as alluded to above. This can be seen in Figure 3.3 and is demonstrated further in Table 3.4. The percentage of errors observed was not statistically significant in CHWs when compared to PWs.

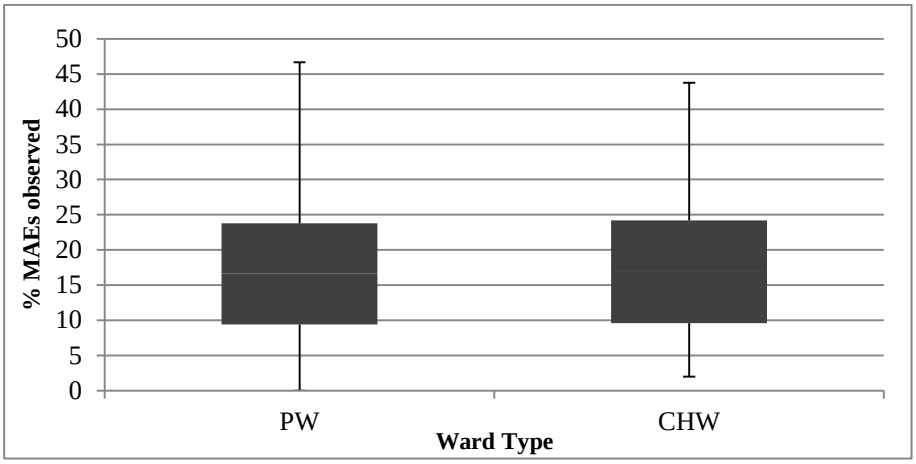

Figure 3.3: Box plot for error rate shown against ward type.
The PWs have median 16.7% errors (range 0-46.7) and CHWs 16.9% errors (range 2-43.8).

Table 3.4: The ANOVA pairwise comparisons for the % errors observed at ward type
Dependent variable: % MAEs observed

(I) Ward type	(J) Ward type	Mean difference (I-J)	S.E.	*p*-value	95% CI for difference	
					Lower bound	Upper bound
CHW	PW	.167	2.855	.954	-5.539	5.873
PW	CHW	-.167	2.855	.954	-5.873	5.539

3.2.1.2 Hospital ward codename

The hospital ward codename and the total OEs observed for each ward are shown in Table 3.5. The highest OEs observed were in community hospital ward 9 (CHW9) with 251 OEs, followed by CHW2 with 191 OEs, then psychiatric ward 9 (PW9) with 188 OEs. The lowest OEs observed were in PW1 with 30 OEs and slightly higher OEs observed in PW3 and PW5.

Table 3.5 also shows the number of MAEs observed for each ward and therefore the error rates at ward level. It becomes apparent, looking at Table 3.5 that the error rate was much higher for certain wards such as CHW1 (31.3%), PW8 (26.2%), PW3 (25.6%) and CHW2 (25.1%), compared to, say, PW1 (3.3%), PW10 (8.9%), CHW6 (9.1%) and CHW7 (10.3%). On the other hand, Table 3.6 shows the highest average

OEs was in CHW9 (62.8) followed by CHW3 and CHW2 (58.3 and 47.8 respectively). The lowest average OEs was in PW3 and PW5.

In addition, the mean error rate was higher for certain wards such as PW8 (30.8%), CHW1 (25.3%), PW3 (25.3%) and CHW2 (25%) compared to PW1 (3.9%), PW10 (7.7%), and CHW6 (8.7%). Furthermore, Figure 3.4 illustrates the median values and ranges of OEs observed in hospital wards, and Figure 3.5 clarify the median values and ranges of error rate in hospital wards.

Table 3.5: The total OEs observed according to hospital wards as well as the number of MAEs and the error rate arranged in increasing order of OEs

Wards	Mode of Administration	Total OEs	No. of MAEs	Total MAE rate %†
(PW1)	Bedside-prepared in clinic room	30	1	3.3%
(PW3)	Bedside-prepared in clinic room	39	10	25.6%
(PW5)	Bedside-prepared in clinic room	39	7	17.9%
(PW10)	Bedside-prepared in clinic room	56	5	8.9%
(CHW7)	Bedside-trolley	87	9	10.3%
(CHW1)	Bedside-patient lockers	96	30	31.3%
(CHW8)	Bedside-patient lockers	97	16	16.5%
(PW4)	Queue	98	12	12.2%
(CHW6)	Bedside-trolley	99	9	9.1%
(PW8)	Bedside-prepared in clinic room	107	28	26.2%
(CHW4)	Bedside-patient lockers	124	24	19.4%
(PW7)	Queue	126	16	12.7%
(CHW5)	Bedside-trolley	129	24	18.6%
(PW2)	Mixed and queue	132 (19,113)	15	11.4%
(PW6)	Bedside-prepared in clinic room and mixed	173 (81,92)	31	17.9%
(CHW3)	Bedside-trolley	175	20	11.4%
(PW9)	Queue	188	25	13.3%
(CHW2)	Bedside-patient lockers	191	48	25.1%
(CHW9)	Bedside-patient lockers	251	37	14.7%

†percentage error rate calculated as a percentage of total OEs for that hospital ward

Table 3.6: The average OEs observed, mean error rate according to hospital wards as well as their standard deviation

Wards	No. of observation visits (no. patients and whether *M*orning, *L*unch, *E*vening, *N*ight)	Average OEs[a]	S.D	Mean error rate %[b]	S.D
(PW1)	2 (*6M, 5M*)	15	1.4	3.6%	5.1
(PW3)	3 (*8M,3L, 3E*)	13	12.1	25.3%	8.4
(PW5)	3 (*5M, 4E,4N*)	13	8.7	18%	4
(PW10)	3 (*12M, 6L, 7E*)	18.7	13.6	7.7%	7.2
(CHW7)	3 (*8L, 10E, 12N*)	29	9.8	11.2%	5.2
(CHW1)	3 (9*M*, 7*L*, 8*N*)	32	19.7	25.3%	17
(CHW8)	3 (*6M, 9L, 11N*)	32.3	11.2	17.9%	6.2
(PW4)	4 (*13M, 7L, 8E,23N*)	24.5	20	15.4%	8.5
(CHW6)	3 (*6M, 9L, 12N*)	33	4.6	8.7%	4.9
(PW8)	4 (*6M, 7L, 5E, 14N*)	26.8	13.9	30.8%	14.3
(CHW4)	4 (*9M, 8L, 4E, 11N*)	31	20.2	21.2%	15.8
(PW7)	4 (*15M, 6L, 6E, 17N*)	31.5	19.4	14.2%	11
(CHW5)	3 (*6M, 12E, 10N*)	43	13.7	21.4	15.2
(PW2)	4 (*17M, 9L, 8E, 20N*)	33	23.3	13.2%	6.6
(PW6)	4 (*16M, 5L, 15E, 17N*)	43.3	31.2	22.5%	11
(CHW3)	3 (*14M, 9L, 14E*)	58.3	43.8	15.2%	8.5
(PW9)	4 (*22M, 13L, 12E, 27N*)	47	30.2	19.8%	16.9
(CHW2)	4 (*12M, 10L, 9E, 12N*)	47.8	30.9	25%	8.7
(CHW9)	4 (*13M, 14L, 14E, 14N*)	62.8	31.6	14%	11.2

[a]calculated as total OEs for each visit/no. of observation visits. [b]percentage mean error rate calculated as a total percentage of error rate for each visit for that hospital ward/no. of observation visits

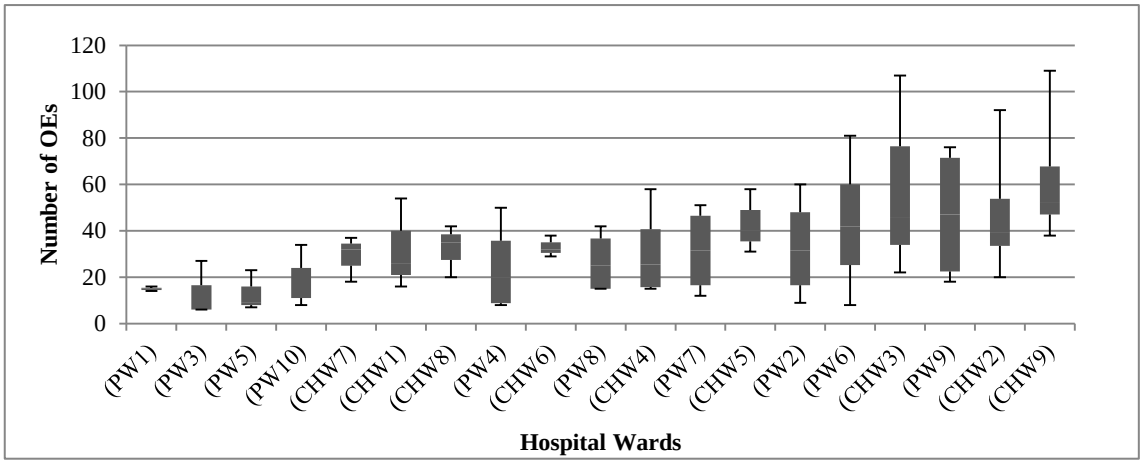

Figure 3.4: Box plot for the OEs shown against hospital ward code names.
The PW1 have a median 15 OEs (range 14-16), PW3 6 OEs (6-27), PW5 9 OEs (7-23), PW10 14 OEs (8-34), CHW7 32 OEs (18-37), CHW1 26 OEs (16-54), CHW8 35 OEs (20-42), PW4 20 OEs (8-50), CHW6 32 OEs (29-38), PW8 25 OEs (15-42), CHW4 25.5 OEs (15-58), PW7 31.5 OEs (12-51), CHW5 40 OEs (31-58), PW2 31.5 OEs (9-60), PW6 42 OEs (8-81), CHW3 46 OEs (22-107), PW9 47 OEs (18-76), CHW2 39.5 OEs (20-92) and CHW9 52 OEs (38-109).

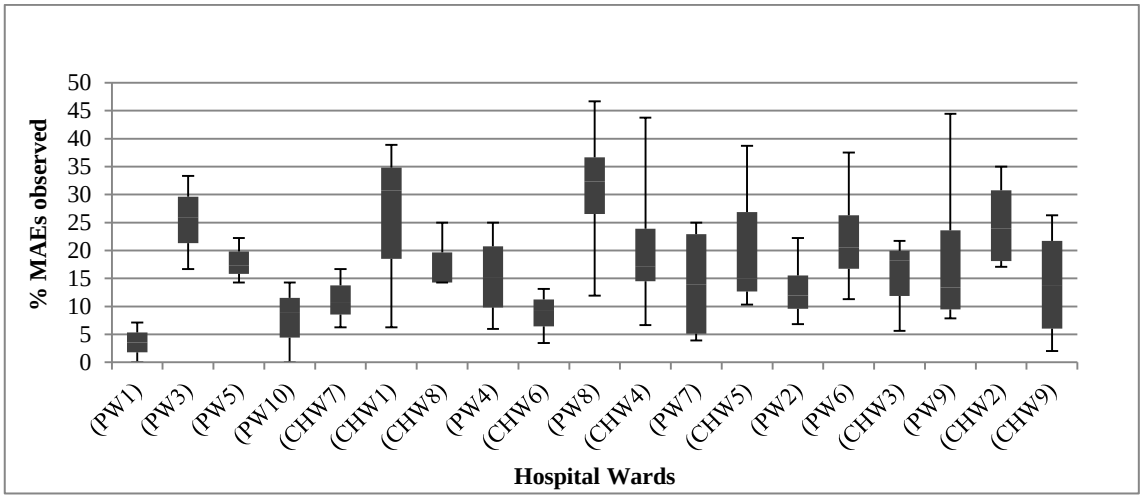

Figure 3.5: Box plot for error rate shown against hospital ward code names.
The PW1 have a median 3.6% errors (range 0-7.1), PW3 25.9% errors (16.7-33.3), PW5 17.4% errors (14.3-22.2), PW10 8.8% errors (0-14.3), CHW7 10.8% errors (6.3-16.7), CHW1 30.8% errors (6.3-38.9), CHW8 14.3% errors (14.3-25), PW4 15.2% errors (6-25), CHW6 9.4% errors (3.4-13.2), PW8 32.4% errors (11.9-46.7), CHW4 17.2% errors (6.7-43.8), PW7 13.9% errors (3.9-25), CHW5 15% errors (10.3-38.7), PW2 11.9% errors (6.8-22.2), PW6 20.5% errors (11.3-37.5), CHW3 18.2% errors (5.6-21.7), PW9 13.3% errors (7.9-44.4), CHW2 23.9% errors (17.1-35) and CHW9 13.8% errors (2-26.3).

3.2.1.3 Wards administration round time

Table 3.7 shows the total OEs observed according to each ward administration round time, the number of MAEs and the respective error rate. It demonstrates that most of OEs observed were at morning rounds 08:00 with 957 OEs, and night rounds 22:00 with 627 OEs. The average OEs was higher for 08:00 with (50.4) and at 22:00 with (41.8) as shown in Table 3.8. This is graphically illustrated in Figure 3.6 showing the median values and ranges.

Table 3.7: The total OEs observed at each ward round time as well as the number of MAEs and the error rate

Time observed	Total OEs	No. of MAEs	Total MAE rate%[†]
08:00 (morning)	957	175	18.3%
12:00 (lunchtime)	273	60	21.9%
18:00 (evening)	380	59	15.5%
22:00 (night time)	627	73	11.6%

[†]percentage error rate calculated as a percentage of total OEs for that time point

Table 3.8: The average OEs observed, mean error rate at each ward round time as well as their standard deviation

Time observed	No. of observation visits	Average OEs[a]	S.D	Mean error rate%[b]	S.D
08:00 (morning)	19	50.4	29.2	18%	11.1
12:00 (lunchtime)	16	17.1	8.9	22%	12.3
18:00 (evening)	15	25.3	16.6	18%	13.2
22:00 (night time)	15	41.8	15.4	13%	6.8

[a]calculated as total OEs for each visit/no. of observation visits. [b]percentage mean error rate calculated as a total percentage of error rate for each visit for that time point/no. of observation visits

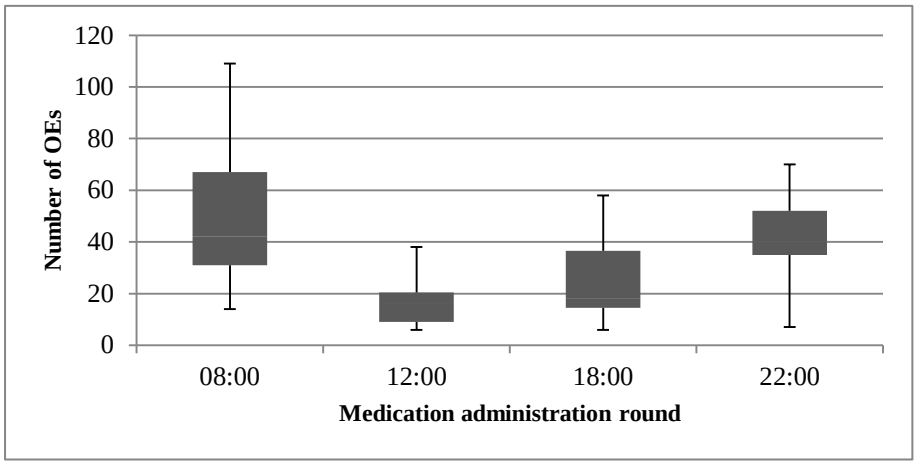

Figure 3.6: Box plot for the OEs shown against observation time.
The morning rounds have a median 42 OEs (range 14-109), lunchtime rounds 16 OEs (range 6-38), evening rounds 18 OEs (range 6-58) and night rounds 40 OEs (range 7-70).

Statistically, the number of OEs were significantly greater during the morning round compared to the lunchtime (p-value <0.001) and evening (p-value =0.001) rounds as tested using ANOVA (univariate analysis of variance) pairwise comparisons (Table 3.9). The number of OEs were significantly greater during the night time round compared to the lunchtime (p-value =0.001) and evening (p-value <0.05) rounds.

Table 3.9: The ANOVA pairwise comparisons for the total OEs observed at each ward round time

Dependent variables: OEs

(I) Medication round time	(J) Medication round time	Mean difference (I-J)	S.E.	*p*-value	95% CI for difference	
					Lower bound	Upper bound
8:00	12:00	33.306*	6.696	**.000**	19.916	46.696
	18:00	25.035*	6.816	**.001**	11.405	38.665
	22:00	8.568	6.816	.214	-5.062	22.198
12:00	8:00	-33.306*	6.696	**.000**	-46.696	-19.916
	18:00	-8.271	7.093	.248	-22.453	5.912
	22:00	-24.738*	7.093	**.001**	-38.920	-10.555
18:00	8:00	-25.035*	6.816	**.001**	-38.665	-11.405
	12:00	8.271	7.093	.248	-5.912	22.453
	22:00	-16.467*	7.206	**.026**	-30.876	-2.057
22:00	8:00	-8.568	6.816	.214	-22.198	5.062
	12:00	24.738*	7.093	**.001**	10.555	38.920
	18:00	16.467*	7.206	**.026**	2.057	30.876

Despite seeing the least number of OEs during the lunchtime round, the highest error rate (21.9%) was observed during these rounds. The lowest error rate (11.6%) was found in the night rounds. Similarly, the mean error rate was higher for 12:00 (22%) and the lower mean error was at 22:00 with (13%) Table 3.7 and Table 3.8. Further illustrates in Table 3.10 and Figure 3.7. The percentage of errors observed were significantly higher during the lunch round time only when compared to the night round time (*p*-value <0.05).

Table 3.10: The ANOVA pairwise comparisons for the % errors observed at each ward round time

Dependent variable: % MAEs observed

(I) Medication round time	(J) Medication round time	Mean difference (I-J)	S.E.	*p*-value	95% CI for difference	
					Lower bound	Upper bound
8:00	12:00	-4.438	3.772	.244	-11.980	3.105
	18:00	-.200	3.840	.959	-7.878	7.478
	22:00	5.600	3.840	.150	-2.078	13.278
12:00	8:00	4.438	3.772	.244	-3.105	11.980
	18:00	4.238	3.995	.293	-3.751	12.226
	22:00	10.038*	3.995	**.015**	2.049	18.026
18:00	8:00	.200	3.840	.959	-7.478	7.878
	12:00	-4.238	3.995	.293	-12.226	3.751
	22:00	5.800	4.059	.158	-2.317	13.917
22:00	8:00	-5.600	3.840	.150	-13.278	2.078
	12:00	-10.038*	3.995	**.015**	-18.026	-2.049
	18:00	-5.800	4.059	.158	-13.917	2.317

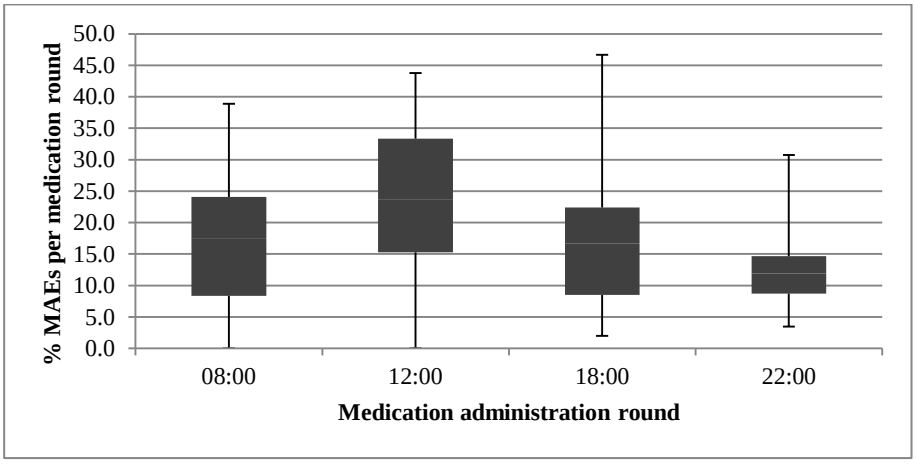

Figure 3.7: Box plot for error rate shown against observation time.

The morning rounds have median 17% errors (range 0-39), lunchtime rounds 24% errors (range 0-44), evening rounds 17% errors (range 2-47) and night rounds 12% errors (range 3-31).

To summarise, the above analysis indicates that while there were more OEs in the morning and night time round, in fact the error rate was greater during the lunchtime round.

3.2.1.4 Wards administration round day

The total OEs and average OEs observed and the total error rate and mean error rate according to the day of the week are shown in Table 3.11 and Table 3.12. This is graphically illustrated in Figure 3.8 which shows the data range. Figure 3.9 illustrates the error rate ranges according to OEs.

Table 3.11: The total OEs observed at each ward round day as well as the number of MAEs and the error rate

Day observed	Total OEs	No. of MAEs	Total MAE rate %[†]
Monday	473	93	19.7%
Tuesday	511	90	17.6%
Wednesday	462	78	16.9%
Thursday	532	63	11.8%
Friday	259	43	16.6%

[†]percentage error rate calculated as a percentage of total OEs for that day point

Table 3.12: The average OEs observed, mean error rate at each ward round day as well as their standard deviation

Day observed	No. of observation visits	Average OEs[a]	S.D	Mean error rate%[b]	S.D
Monday	14	33.8	26.5	19.3%	11.6
Tuesday	15	34.1	24.9	17.7%	12.2
Wednesday	14	33	22	18.9%	13.5
Thursday	14	38	26	16.2%	9.9
Friday	8	32.4	18.1	17%	10.2

[a]calculated as total OEs for each visit/no. of observation visits. [b]percentage mean error rate calculated as a total percentage of error rate for each visit for that day point/no. of observation visits

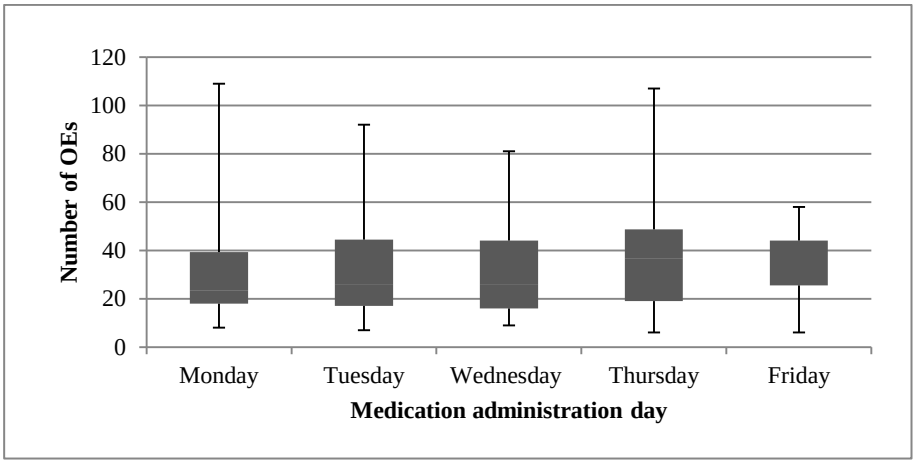

Figure 3.8: Box plot for the OEs shown against observation weekday.
Monday rounds have a median 23.5 OEs (range 8-109), Tuesday rounds 26 OEs (range 7-92), Wednesday rounds 26 OEs (range 9-81), Thursday rounds 36.5 OEs (range 6-107) and Friday 31.5 OEs (range 6-58).

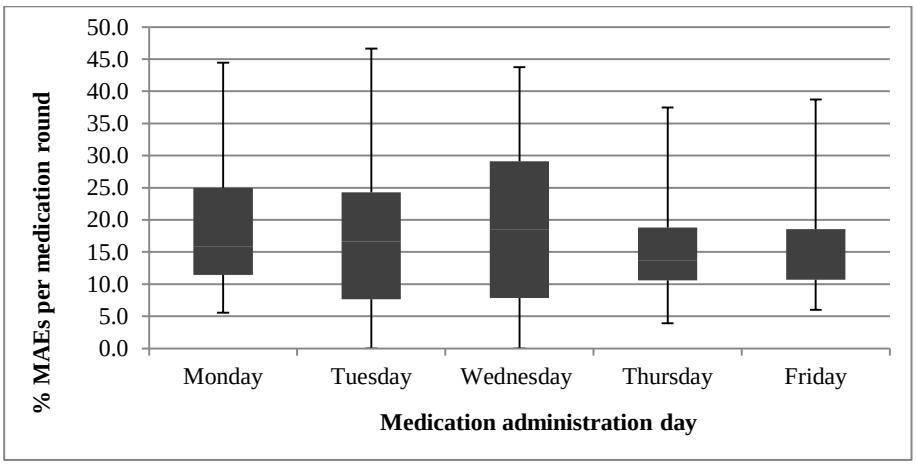

Figure 3.9: Box plot for error rates shown against observation weekday.
Monday rounds have median 15.8% errors (range 5.6-44.2), Tuesday rounds 16.7% errors (range 0-46.7), Wednesday rounds 18.5% errors (range 0-43.8), Thursday rounds 13.7% errors (range 3.9-37.5) and Friday 15.5% errors (range 6-38.7).

Table 3.13 demonstrates that the comparison between the number of OEs at each day observed were not statistically significant. Also, Table 3.14 shows that error rate observed was not statistically significant when compared between the different days of the week.

Table 3.13: The ANOVA pairwise comparisons for the total OEs observed at each day of week
Dependent variable: OEs

(I) Day of week	(J) Day of week	Mean difference (I-J)	S.E.	*p*-value	95% CI for difference	
					Lower bound	Upper bound
Monday	Tuesday	-.281	9.003	.975	-18.290	17.728
	Wednesday	.786	9.157	.932	-17.531	19.102
	Thursday	-4.214	9.157	.647	-22.531	14.102
	Friday	1.411	10.738	.896	-20.068	22.889
Tuesday	Monday	.281	9.003	.975	-17.728	18.290
	Wednesday	1.067	9.003	.906	-16.942	19.076
	Thursday	-3.933	9.003	.664	-21.942	14.076
	Friday	1.692	10.607	.874	-19.525	22.908
Wednesday	Monday	-.786	9.157	.932	-19.102	17.531
	Tuesday	-1.067	9.003	.906	-19.076	16.942
	Thursday	-5.000	9.157	.587	-23.317	13.317
	Friday	.625	10.738	.954	-20.853	22.103
Thursday	Monday	4.214	9.157	.647	-14.102	22.531
	Tuesday	3.933	9.003	.664	-14.076	21.942
	Wednesday	5.000	9.157	.587	-13.317	23.317
	Friday	5.625	10.738	.602	-15.853	27.103
Friday	Monday	-1.411	10.738	.896	-22.889	20.068
	Tuesday	-1.692	10.607	.874	-22.908	19.525
	Wednesday	-.625	10.738	.954	-22.103	20.853
	Thursday	-5.625	10.738	.602	-27.103	15.853

Table 3.14: The ANOVA pairwise comparisons for the % errors observed at each day of week
Dependent variable: % MAEs observed

(I) Day of week	(J) Day of week	Mean difference (I-J)	S.E.	*p*-value	95% CI for difference	
					Lower bound	Upper bound
Monday	Tuesday	1.593	4.346	.715	-7.101	10.287
	Wednesday	.429	4.421	.923	-8.414	9.271
	Thursday	3.114	4.421	.484	-5.728	11.957
	Friday	2.300	5.184	.659	-8.069	12.669
Tuesday	Monday	-1.593	4.346	.715	-10.287	7.101
	Wednesday	-1.165	4.346	.790	-9.859	7.529
	Thursday	1.521	4.346	.728	-7.173	10.215
	Friday	.707	5.120	.891	-9.536	10.949
Wednesday	Monday	-.429	4.421	.923	-9.271	8.414
	Tuesday	1.165	4.346	.790	-7.529	9.859
	Thursday	2.686	4.421	.546	-6.157	11.528
	Friday	1.871	5.184	.719	-8.497	12.240
Thursday	Monday	-3.114	4.421	.484	-11.957	5.728
	Tuesday	-1.521	4.346	.728	-10.215	7.173
	Wednesday	-2.686	4.421	.546	-11.528	6.157
	Friday	-.814	5.184	.876	-11.183	9.555
Friday	Monday	-2.300	5.184	.659	-12.669	8.069
	Tuesday	-.707	5.120	.891	-10.949	9.536
	Wednesday	-1.871	5.184	.719	-12.240	8.497
	Thursday	.814	5.184	.876	-9.555	11.183

3.2.1.5 Gender of the nurse staff

The gender of the staff member being observed was recorded during the observations. Table 3.15 shows the total OEs observed according to gender of staff as well as the number of MAEs and the error rate. It can be seen that OEs observed with female nurses were far higher (1774) than the OEs observed with male nurses (463). However, the average OEs was slightly higher with female nurses as shown in Table 3.16. This is also indicated in Figure 3.10. Further results are shown in Table 3.17 where the number of OEs observed with female staff was not statistically significant compared to male staff.

Table 3.15: The total OEs observed according to gender of nurse as well as the number of MAEs and the error rate

The gender of staff	Total OEs	No. of MAEs	Total MAE rate %[†]
Male	463	74	15.9%
Female	1774	293	16.5%

[†]percentage error rate calculated as a percentage of total OEs for that gender

Table 3.16: The average OEs observed, the mean error rate according to gender of nurse as well as their standard deviation

The gender of staff	No. of observation visits	Average OEs[a]	S.D	Mean error rate%[b]	S.D
Male	16	28.9	20	17.1%	14
Female	49	36.2	24.5	18.1%	10.5

[a]calculated as total OEs for each observation visit/no. of observation visits. [b]percentage mean error rate calculated as a total percentage of error rate for each observation visit for that gender point/no. of observation visits

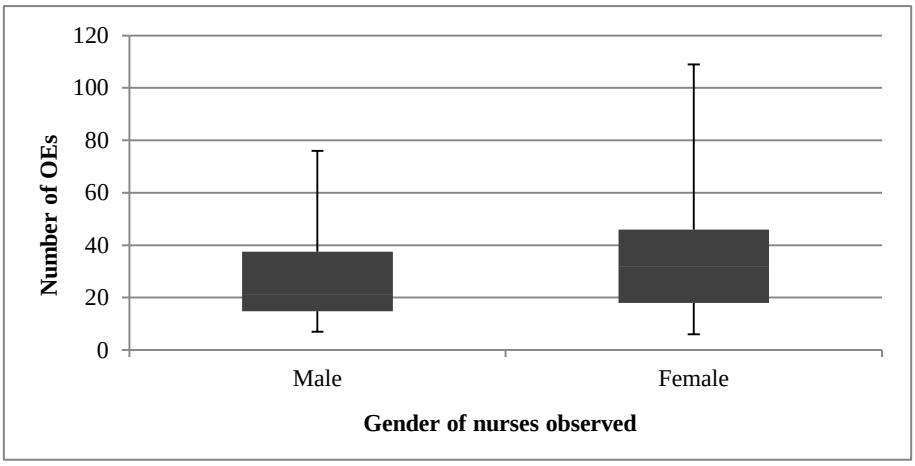

Figure 3.10: Box plot for the OEs observed according to gender of nurse staff.

Males have a median 21 OEs (range 7-76) and female 32 OEs (range 6-109)

Table 3.17: The ANOVA pairwise comparisons for the total OEs observed for nurse gender
Dependent variable: OEs

(I) Nurse gender	(J) Nurse gender	Mean difference (I-J)	S.E.	*p*-value	95% CI for difference	
					Lower bound	Upper bound
Female	Male	7.267	6.770	.287	-6.262	20.796
Male	Female	-7.267	6.770	.287	-20.796	6.262

From Table 3.15 and Table 3.16 the total error rate and the mean error rate against gender of nurse staff were almost the same between male and female which is presents in Figure 3.11. Likewise, Table 3.18 indicates the percentage of errors observed was not significantly with female nurse when compared with male nurses.

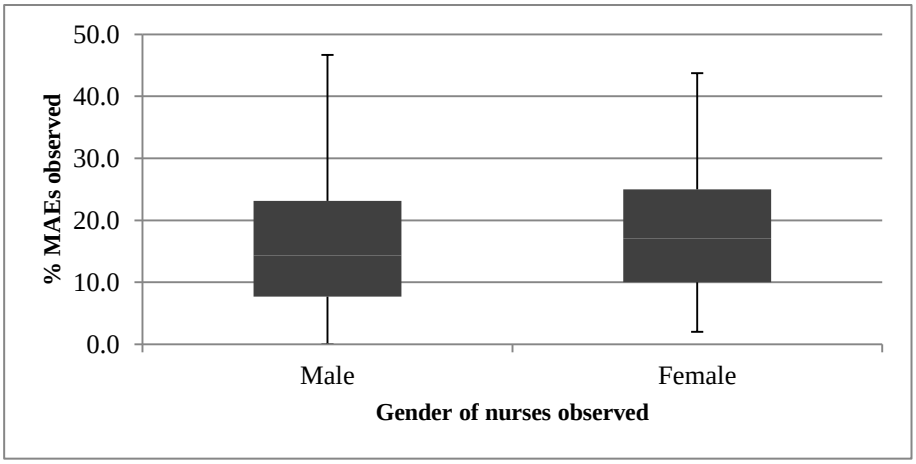

Figure 3.11: Box plot for error rate observed according to gender of nurse staff.
Males have a median 14.3% error (range 0-46.7) and female 17.1% errors (range 2-43.8).

Table 3.18: The ANOVA pairwise comparisons for the % errors observed for nurse gender
Dependent variable: % MAEs observed

(I) Nurse gender	(J) Nurse gender	Mean difference (I-J)	S.E.	*p*-value	95% CI for difference	
					Lower bound	Upper bound
Female	Male	1.043	3.302	.753	-5.555	7.641
Male	Female	-1.043	3.302	.753	-7.641	5.555

3.2.1.6 Nurse staff grade or status

In relation to the staff grade, most OEs were observed when shadowing band 5 nurses then band 6 nurses, and the lowest OEs were with bank nurses (Table 3.19). On the other hand, Table 3.20 shows the average OEs was higher in band 6 nurses with (52) OEs, then bank nurses (46) and lower for agency nurses (27.5), which is demonstrates also in Figure 3.12. Applying the ANOVA test, it can be seen from Table 3.21 that the number of OEs observed were significantly greater with band 6 nurses compared to band 5 nurses (*p*-value <0.05) and agency nurses (*p*-value <0.05). Table 3.22 shows the average OEs observed, according to grade or status of nurse staff as well as the mean error rate in CHWs, and Table 3.23 illustrates the average OEs observed, according to grade or status of nurse staff as well as the mean error rate in PWs.

Table 3.19: The total OEs observed according to grade or status of nurse staff as well as the number of MAEs and the error rate

Grade or status of staff	**Total OEs**	**No. of MAEs**	**Total MAE rate %**[†]
Band 5	1390	228	16.4%
Band 6	416	52	12.5%
Bank	46	10	21.7%
Agency	385	77	20%

[†]percentage error rate calculated as a percentage of total OEs for that grade point

Table 3.20: The average OEs observed, the mean error rate according to grade or status of nurse staff as well as their standard deviation

Grade or status of staff	No. of observation visits	Average OEs[a]	S.D	Mean error rate%[b]	S.D
Band 5	42	33.1	20.7	18.5%	11.2
Band 6	8	52	30.9	14.7%	12.2
Bank	1	46	-	21.7%	-
Agency	14	27.5	24.6	17.5%	12.4

[a]calculated as total OEs for each observation visit/no. of observation visits. [b]percentage mean error rate calculated as a total percentage of error rate for each observation visit for that grade point/no. of observation visits

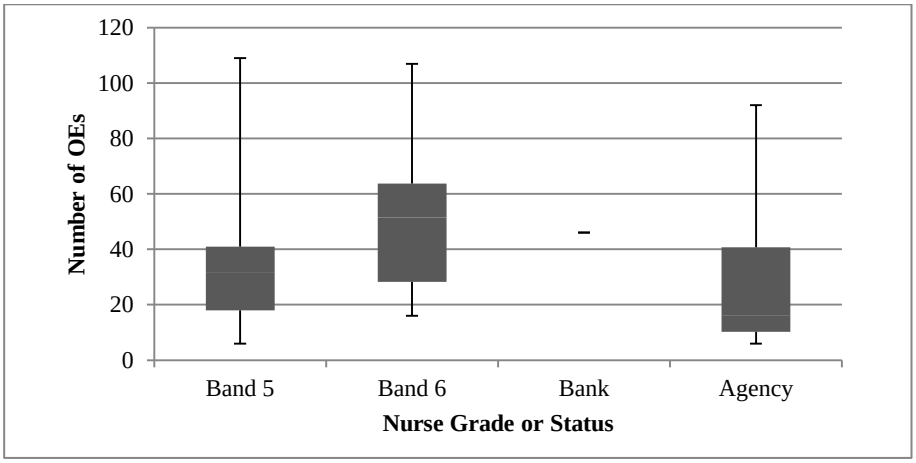

Figure 3.12: Box plot for the OEs shown against nurse grade or status.
Band 5 nurses have a median 31.5 OEs (range 6-109), Band 6 51.5 OEs (range 16-107), Bank 46 OEs with no range (observed once), and Agency 16 OEs (range 6-92).

Table 3.21: The ANOVA pairwise comparisons for the total OEs observed for nurse grade or status

Dependent variable: OEs

(I) Nurse grade	(J) Nurse grade	Mean difference (I-J)	S.E.	*p*-value	95% CI for difference	
					Lower bound	Upper bound
Band 5	Band 6	-18.905*	8.851	**.037**	-36.604	-1.206
	Bank	-12.905	23.217	.580	-59.329	33.520
	Agency	5.595	7.081	.432	-8.564	19.755
Band 6	Band 5	18.905*	8.851	**.037**	1.206	36.604
	Bank	6.000	24.337	.806	-42.665	54.665
	Agency	24.500*	10.169	**.019**	4.165	44.835
Bank	Band 5	12.905	23.217	.580	-33.520	59.329
	Band 6	-6.000	24.337	.806	-54.665	42.665
	Agency	18.500	23.750	.439	-28.992	65.992
Agency	Band 5	-5.595	7.081	.432	-19.755	8.564
	Band 6	-24.500*	10.169	**.019**	-44.835	-4.165
	Bank	-18.500	23.750	.439	-65.992	28.992

Table 3.22: The average OEs observed, according to grade or status of nurse staff as well as the mean error rate in CHWs

Grade or status of staff	No. of observation	Average OEs	S.D	Mean error rate%	S.D
Band 5	15	39.8	21.5	16.8%	9.6
Band 6	6	47	33.7	14.7%	14.3
Bank	1	46	-	21.7%	-
Agency	8	40.5	25.7	22.3%	12.5

Table 3.23: The average OEs observed, according to grade or status of nurse staff as well as the mean error rate in PWs

Grade or status of staff	No. of observation	Average OEs	S.D	Mean error rate%	S.D
Band 5	27	29.4	19.7	19.5%	12.1
Band 6	2	67	19.8	14.9%	5.1
Bank	0	0	0	0	0
Agency	6	10.2	3.9	11.2%	9.8

It can be seen from Table 3.19 that the total percentage of errors associated with bank and agency nurses were higher than those associated with band 5 and band 6 nurses. However, in Table 3.20 the mean error rate percentages were similar between the nurse grades. Figure 3.13 indicates no major difference in the percentage of errors between nurse grades. Correspondingly, as shown in Table 3.24 there were no statistically significant difference when comparing the percentage MAEs observed for each nurse grade.

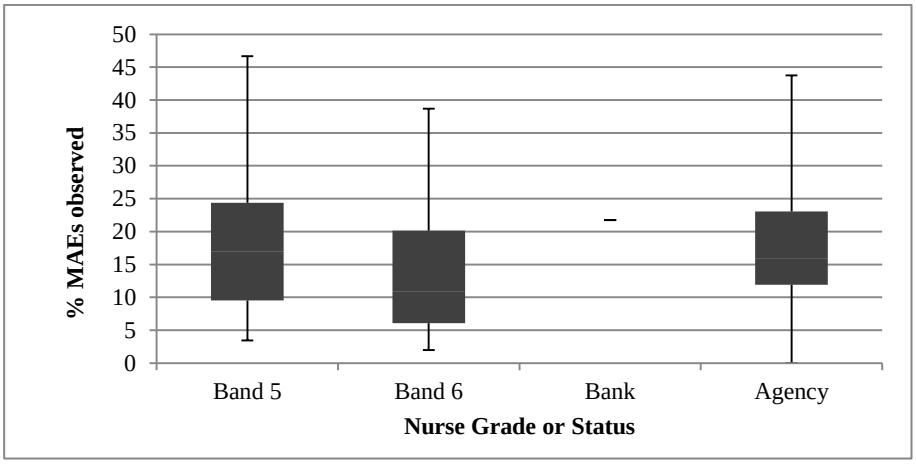

Figure 3.13: Box plot for error rates shown against nurse grade or status.
Band 5 nurses have a median 16.9% error (range 3.4-46.6), Band 6 10.8% errors (range 2-38.7), Bank 21.7% errors with no rang due to observed once, and Agency 15.8% errors (range 0-43.8).

Table 3.24: The ANOVA pairwise comparisons for the % errors observed for nurse grade or status
Dependent variable: % MAEs observed

(I) Nurse grade	(J) Nurse grade	Mean difference (I-J)	S.E.	*p*-value	95% CI for difference	
					Lower bound	Upper bound
Band 5	Band 6	3.804	4.468	.398	-5.130	12.738
	Bank	-3.183	11.719	.787	-26.617	20.251
	Agency	.981	3.574	.785	-6.166	8.128
Band 6	Band 5	-3.804	4.468	.398	-12.738	5.130
	Bank	-6.988	12.285	.572	-31.552	17.577
	Agency	-2.823	5.133	.584	-13.088	7.441
Bank	Band 5	3.183	11.719	.787	-20.251	26.617
	Band 6	6.988	12.285	.572	-17.577	31.552
	Agency	4.164	11.989	.730	-19.809	28.137
Agency	Band 5	-.981	3.574	.785	-8.128	6.166
	Band 6	2.823	5.133	.584	-7.441	13.088
	Bank	-4.164	11.989	.730	-28.137	19.809

3.2.1.7 Drug group

The category of drugs observed was also recorded. It can be seen in Table 3.25 that a much higher number of OEs related to non-psychiatric drugs (1713) with the OEs relating to psychiatric drugs being (524). Furthermore, the error rate detected in the non-psychiatric drug group was (18.2%) whereas that found in the psychiatric drug group was (10.5%). Table 3.26 shows that the MAEs were significantly higher in the non-psychiatric drug group compared to the psychiatric drug group (*p*-value <0.001).

Table 3.27 illustrates the total OEs observed according to drug group as well as the number of MAEs in CHWs and PWs. In addition, in Appendix 13 Table 1 includes the main medications involved in MAEs including whether these were in the critical list medications or not and shows that most of these medications were not critical. Moreover, it can be seen in Appendix 13 Table 2 the number of MAEs in terms of route of administration observed. The oral route had the far highest number of errors followed by the topical route.

Table 3.25: The total OEs observed according to drug group as well as the number of MAEs and the error rate

Drug group	**Total OEs**	**No. of MAEs**	**Total MAE rate %**[†]
Non-psychiatric drug	1713	312	18.2%
Psychiatric drug	524	55	10.5%

[†]percentage error rate calculated as a percentage of total OEs for that drug group point

Table 3.26: The ANOVA pairwise comparisons for the MAEs observed for drug group Dependent variable: MAEs

(I) Drug group	(J) Drug group	Mean difference (I-J)	S.E	*p*-value	95% CIfor difference	
					Lower bound	Upper bound
Non-psychiatric drug	Psychiatric drug	.077*	.019	**<0.001**	.039	.115
Psychiatric drug	Non-psychiatric drug	-.077*	.019	**<0.001**	-.115	-.039

Table 3.27: The total OEs observed according to drug group as well as the number of MAEs in CHWs and PWs

Drug group	**Total OEs in CHWs**	**No. of MAEs in CHWs**	**Total OEs in PWs**	**No. of MAEs in PWs**
Non-psychiatric drug	1172	208	541	104
Psychiatric drug	77	9	447	46

3.2.1.8 Wards busy with other activity or not

Whether any ward busy with other activity is taking place during the medication rounds was also recorded. As shown in Table 3.28 the total OEs observed on busy wards with

other activities taking place were more than the OEs observed in quiet wards. However, the average OEs was quite similar between the wards with other activity compared with wards with no other activity as revealed in Table 3.29. This is also shown in Figure 3.14. Table 3.30 shows no statistically significantly difference of OEs observed in wards with other activity compared with wards with no other activity.

Table 3.28: The total OEs observed according to whether wards had other activities taking place or not as well as the number of MAEs and the error rate

Ward busy with other activity	Total OEs	No. of MAEs	Total MAE rate[†]
Yes	1545	291	18.8%
No	692	76	10.9%

[†]percentage error rate calculated as a percentage of total OEs for that ward activity point

Table 3.29: The average OEs observed, the mean error rate according to whether wards had other activities taking place or not as well as their standard deviation

Ward busy with other activity	No. of observation visits	Average OEs[a]	S.D	Mean error rate%[b]	S.D
Yes	46	33.6	23.2	19.5%	11.6
No	19	36.4	24.8	13.9%	10

[a]calculated as total OEs for each observation visit/no. of observation visits. [b]percentage mean error rate calculated as a total percentage of error rate for each observation visit for that ward activity point/no. of observation visits

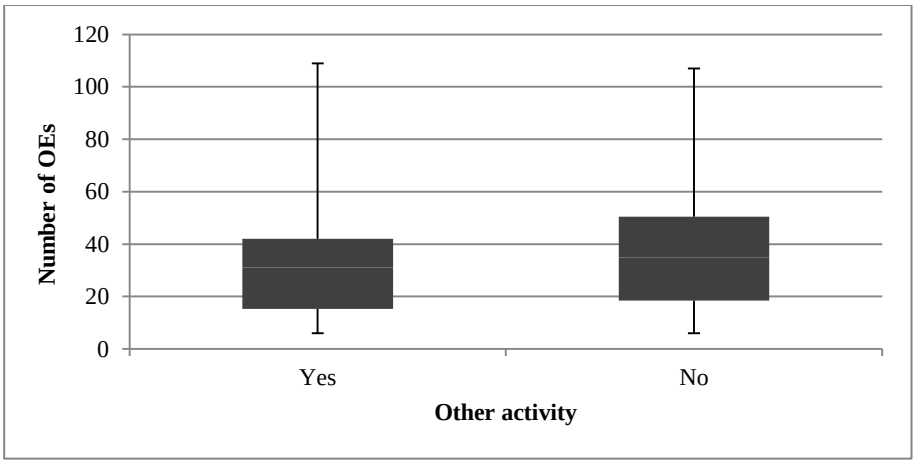

Figure 3.14: Box plot for the OEs observed according to the wards including other activities or not.
The presence of other activity has a median 31 OEs (range 6-109) and no activity has 35 OEs (range 6-107).

Table 3.30: The ANOVA pairwise comparisons for the total OEs observed for wards that had other activities or not
Dependent variable: OEs

(I) Other activity	(J) Other activity	Mean difference (I-J)	S.E.	*p*-value	95% CI for difference	
					Lower bound	Upper bound
Yes	No	-2.834	6.461	.662	-15.745	10.076
No	Yes	2.834	6.461	.662	-10.076	15.745

As shown in Table 3.29 the mean error rate in wards where other activities are taking place at the time of the medication administration round (19.5%) which was slightly higher than the mean error rate in wards without other activities (13.9%) taking place. This is also shown in Figure 3.15 as the median error rate for the wards. In addition, Table 3.31 demonstrates that there was weak evidence (*p*-value = 0.069) of increased mean error rate in the wards with other activity compared with wards with no other activity.

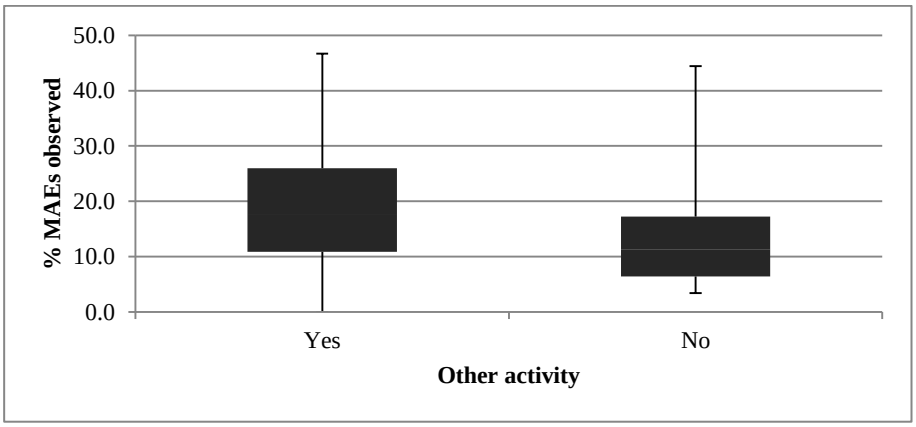

Figure 3.15: Box plot for error rate observed according to whether the wards had other activities taking place or not.
Other activity being present has a median 17.7% error per ward (range 0-46.7) and with no activity 11.3% error per ward (3.4-44.4).

Table 3.31: The ANOVA pairwise comparisons for the % errors observed for wards that had other activities or not
Dependent variable: % MAEs observed

(I) Other activity	(J) Other activity	Mean difference (I-J)	S.E.	*p*-value	95% CI for difference	
					Lower bound	Upper bound
Yes	No	5.640	3.048	.069	-.450	11.731
No	Yes	-5.640	3.048	.069	-11.731	.450

Table 3.32 shows the relationship between the total OEs observed according to the medication administration round time and whether or not there was other activity taking place. All of the OEs observed at the lunchtime round took place on wards that were busy with other activities.

Table 3.32: Relationship between the total OE observed at the round time and the total of OE observed on wards with other activity or not.

	Other activity	
Time of medication administration round	**Yes**	**No**
08:00 (morning)	756	201
12:00 (lunchtime)	273	0
18:00 (evening)	311	69
22:00 (night time)	205	422

3.2.1.9 Nurses interrupted versus nurses not interrupted

As well as recording the other activities taking place, instances of interruptions during the medication administration round were recorded (the nurse interruptions were measured for each OEs). The number of OEs observed with nurses not interrupted during the medication administration round (2061) was greater than that observed with nurses having been interrupted (176) as shown in Table 3.33. On the other hand, the error rate was higher when nurses were interrupted compared to no interruption. Table 3.34 shows that the MAEs were significantly greater when nurses were interrupted compared to when nurses were not interrupted (p-value <0.001).

Table 3.33: The total OE observed according to whether the nurse was interrupted or not as well as the number of MAEs and the error rate

Interruptions	**Total OEs**	**No. of MAEs**	**Total MAE rate %**[†]
No	2061	315	15.3%
Yes	176	52	29.5%

[†]percentage error rate calculated as a percentage of total OEs for that interruptions point

Table 3.34: The ANOVA pairwise comparisons for the MAEs observed for nurses when interrupted or not
Dependent variable: MAEs

(I) Nurse was interrupted	(J) Nurse was interrupted	Mean difference (I-J)	S.E	*p*-value	95% CI for difference	
					Lower bound	Upper bound
No	Yes	-.143*	.030	**<0.001**	-.202	-.083
Yes	No	.143*	.030	**<0.001**	.083	.202

3.2.1.10 The modes of administration

During the medication administration observation; the mode of administration of each ward is recorded. Table 3.35 shows that the number of OEs observed in wards using the bedside-patient locker mode was the highest, and in wards using a mixed mode of administration, it was the lowest. However, Table 3.36 illustrates that the average OEs was lowest in the bedside-prepared in clinic room mode.

This also appeared in Figure 3.16 the OEs median values and ranges. The number of OEs observed were significantly lower in bedside-prepared in clinic room mode compared to bedside using patient lockers mode (*p*-value <0.05) and bedside using trolley mode (*p*-value <0.05) as seen in Table 3.37.

Table 3.35: The OEs observed according to mode of administration as well as the number of MAEs and the error rate

Ward type	**Mode of Administration**	**Total OEs**	**No. of MAEs**	**Total MAE rate %†**
CHWs	Bedside-patient lockers	759	155	20.4%
	Bedside-trolley	490	62	12.7%
PWs	Bedside-prepared in clinic room	343	64	18.6%
	Mixed-bedside and queue	120	20	16.7%
	Queue	525	66	12.6%

†percentage error rate calculated as a percentage of total OEs for that mode of administration point

Table 3.36: The average OEs observed, the mean error rate according to mode of administration as well as their standard deviation

Ward type	Mode of Administration	No. of observation visits	Average OEs[a]	S.D	Mean error rate%[b]	S.D
CHWs	Bedside-patient lockers	18	42.2	25.5	20.6%	11.8
	Bedside-trolley	12	40.8	23.3	14.1%	9.5
PWs	Bedside-prepared in clinic room	15	22.9	19.6	18.6%	13.2
	Mixed-bedside and queue	5	24	18.7	20.8%	10.9
	Queue	15	35	23.2	16%	10.8

[a]calculated as total OEs for each observation visit/no. of observation visits. [b]percentage mean error rate calculated as a total percentage of error rate for each observation visit for that mode of administration point/no. of observation visits

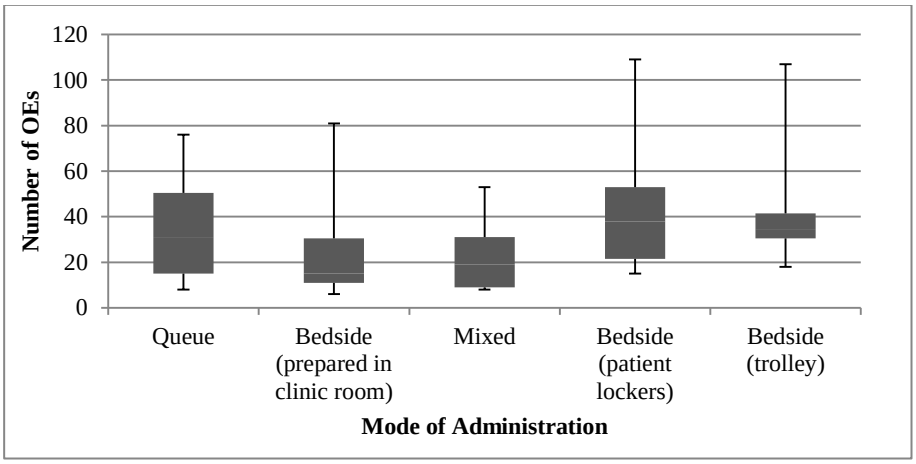

Figure 3.16: Box plot for the OEs shown against mode of administration.
The Queue mode has a median 31 OEs (range 8-76), bedside-prepared in clinic room 15 OEs (range 6-81), Mixed 19 OEs (range 8-53), bedside-patient lockers 38 OEs (range 15-109) and bedside-trolley 34.5 OEs (range 18-107)

Table 3.37: The ANOVA pairwise comparisons for the total OEs observed for mode of administration
Dependent variable: OEs

(I) Mode of administration	(J) Mode of administration	Mean difference (I-J)	S.E.	*p*-value	95% CI for difference	
					Lower bound	Upper bound
Queue	Bedside-prepared in clinic room	12.133	8.346	.151	-4.560	28.827
	Mixed	11.000	11.802	.355	-12.608	34.608
	Bedside-patient lockers	-7.167	7.990	.373	-23.150	8.816
	Bedside-trolley	-5.833	8.852	.512	-23.540	11.873
Bedside-prepared in clinic room	Queue	-12.133	8.346	.151	-28.827	4.560
	Mixed	-1.133	11.802	.924	-24.742	22.475
	Bedside-patient lockers	-19.300*	7.990	**.019**	-35.283	-3.317
	Bedside-trolley	-17.967*	8.852	**.047**	-35.673	-.260
Mixed	Queue	-11.000	11.802	.355	-34.608	12.608
	Bedside-prepared in clinic room	1.133	11.802	.924	-22.475	24.742
	Bedside-patient lockers	-18.167	11.554	.121	-41.278	4.945
	Bedside-trolley	-16.833	12.166	.172	-41.168	7.502
Bedside-patient lockers	Queue	7.167	7.990	.373	-8.816	23.150
	Bedside-prepared in clinic room	19.300*	7.990	**.019**	3.317	35.283
	Mixed	18.167	11.554	.121	-4.945	41.278
	Bedside-trolley	1.333	8.518	.876	-15.705	18.371
Bedside-trolley	Queue	5.833	8.852	.512	-11.873	23.540
	Bedside-prepared in clinic room	17.967*	8.852	**.047**	.260	35.673
	Mixed	16.833	12.166	.172	-7.502	41.168
	Bedside-patient lockers	-1.333	8.518	.876	-18.371	15.705

The medication administered using the bedside-patient locker mode had the highest error rate associated with it (20.4%), followed by the bedside administration where the medication was prepared in the clinic room (18.6%). Bedside administration using the trolley and queuing modes of administration had lower error rates at (12.7% and 12.6% respectively) as shown in Table 3.35.

However, in Table 3.36 there was no significant difference of the mean error rate between the modes of administration. Moreover, Figure 3.17 shows the error rate median values and ranges. Table 3.38 shows that the comparison between the percentages of errors in different mode of administration is not statistically significant.

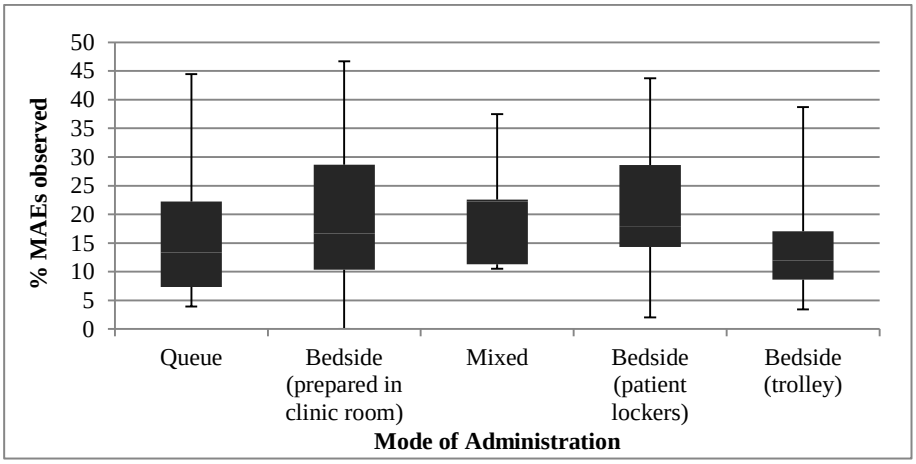

Figure 3.17: Box plot for error rates shown against mode of administration.
The Queue mode have a median 13.3% errors (range 3.9-44.4), bedside-prepared in clinic room 16.7% errors (range 0-46.7), Mixed 22.2% errors (range 10.5-37.5), bedside-patient lockers 17.8% errors (range 2-43.8) and bedside-trolley 12% errors (range 3.4-38.7).

Table 3.38: The ANOVA pairwise comparisons for the % errors observed for mode of administration
Dependent variable: % MAEs observed

(I) Mode of administration	(J) Mode of administration	Mean difference (I-J)	S.E.	*p*-value	95% CI for difference	
					Lower bound	Upper bound
Queue	Bedside-prepared in clinic room	-2.673	4.187	.526	-11.049	5.702
	Mixed	-4.853	5.922	.416	-16.698	6.992
	Bedside-patient lockers	-4.594	4.009	.256	-12.613	3.425
	Bedside-trolley	1.858	4.441	.677	-7.025	10.742
Bedside-prepared in clinic room	Queue	2.673	4.187	.526	-5.702	11.049
	Mixed	-2.180	5.922	.714	-14.025	9.665
	Bedside-patient lockers	-1.921	4.009	.634	-9.940	6.098
	Bedside-trolley	4.532	4.441	.312	-4.352	13.415
Mixed	Queue	4.853	5.922	.416	-6.992	16.698
	Bedside-prepared in clinic room	2.180	5.922	.714	-9.665	14.025
	Bedside-patient lockers	.259	5.797	.965	-11.337	11.854
	Bedside-trolley	6.712	6.104	.276	-5.498	18.921
Bedside-patient lockers	Queue	4.594	4.009	.256	-3.425	12.613
	Bedside-prepared in clinic room	1.921	4.009	.634	-6.098	9.940
	Mixed	-.259	5.797	.965	-11.854	11.337
	Bedside-trolley	6.453	4.274	.136	-2.096	15.001
Bedside-trolley	Queue	-1.858	4.441	.677	-10.742	7.025
	Bedside-prepared in clinic room	-4.532	4.441	.312	-13.415	4.352
	Mixed	-6.712	6.104	.276	-18.921	5.498
	Bedside-patient lockers	-6.453	4.274	.136	-15.001	2.096

3.2.2 The type and frequency of MAEs

Figure 3.18 presents the percentage of MAEs detected by the researcher during the observation by the error type. It can be seen that expiry errors represented the highest proportion of errors with (32%). Moreover, (23%) of errors related to omissions (almost not given 5%, omitted and unsigned 13% and omitted but signed 5%) which gave the second highest type of errors. The third highest proportion of errors related to 'other reason' errors with (16%) (note. rinse mouth after using some corticosteroid inhalers was the most common error detected for 'other reason'). Wrong time errors were the fourth highest type of errors with (13%). In addition, the wrong dose, given but unsigned and formulation errors type were (7%, 5% and 3% respectively). Extra dose errors and prescribed drug errors were the least common type of errors.

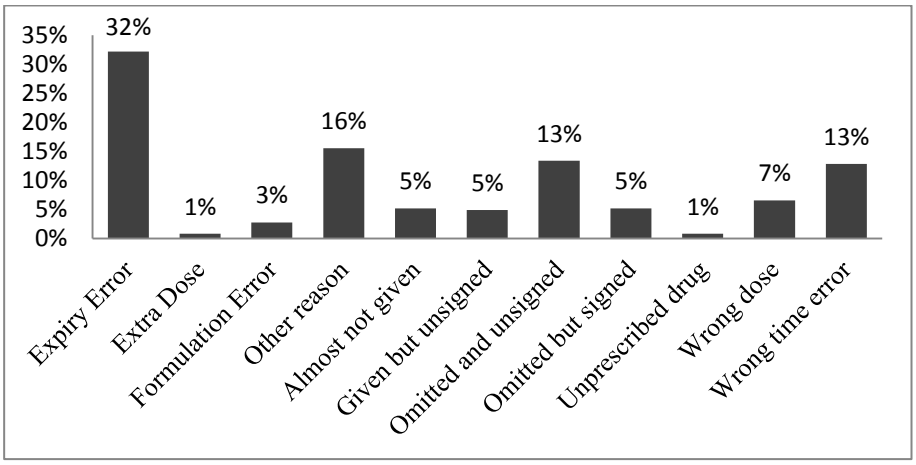

Figure 3.18: The type and frequency of MAEs

Table 3.39 illustrates the type and number of MAEs in wards. It can be seen from the table that expiry errors were the most error type in wards CHW2, PW6, PW8, CHW3, PW9, PW5 and PW10 with 17, 15, 11, 10, 10, 4 and 4 errors, respectively. Moreover, omissions (almost not given, omitted and unsigned and omitted but signed) were the greatest type of errors in CHW5, CHW9, CHW4 and CHW8 with 13, 13, 8, and 6 errors, respectively and the other reason errors in PW2 and PW4 with 11 and 5 errors.

WTEs were the greatest type of errors in CHW1 with 15 errors and PW3 with 6 errors. Furthermore, the expiry errors were higher in CHW2 compared with the expiry errors in the other wards, and WTEs were higher in CHW1 compared with the WTEs in the other wards. Finally, the most WTEs detected were in wards that used bedside patient locker mode of administration CHW1, CHW2 and CHW9 as shown in Table 3.5.

Table 3.39: The type and frequency of MAEs according to code wards name

	Expiry Error	Extra Dose	Formulation Error	Other reason	Almost not given	Given but unsigned	Omitted and unsigned	Omitted but signed	Un-prescribed drug given	Wrong dose	Wrong time error
(PW1)	1										
(PW3)	4										6
(PW5)	4		2				1				
(PW10)	4			1							
(CHW7)	1			1		3	2			2	
(CHW1)	8					6		1			15
(CHW8)	5		1	1		2	3	3		1	
(PW4)	3			5	1		1			2	
(CHW6)	3			3			1	1		1	
(PW8)	11		1	4	2	2	7		1		
(CHW4)	4	3		7	1		1	6		2	
(PW7)	2		3			1	3			5	2
(CHW5)	5			2	10		2	1		4	
(PW2)	2			11	1		1				
(PW6)	15		2	1		1	7	1	1	3	
(CHW3)	10			3			1	6			
(PW9)	10			6	1		7			1	
(CHW2)	17		1	11		2	2			2	13
(CHW9)	9			1	3	1	10		1	1	11

Table 3.40 shows the variety of error types found per 100 observations in both ward type (community hospital and psychiatric wards). Expiry errors were the most frequent type of error with 5 errors per 100 observations in CHWs, and with 5.7 errors per 100 observations in PWs. Omissions (almost not given, omitted and unsigned and omitted but signed) were the second frequent type with 4.3 errors per 100 observations in

CHWs and 3.3 errors per 100 observations in PWs. This indicates that the first and second most frequent type of error was the same in both ward types. Moreover, the third type of error was different between the two ward types, in CHWs it is WTE with 3.1 errors per 100 observations and in PWs it is the 'other reason' error with 2.8 errors per 100 observations.

Table 3.40: The type and the errors found per 100 observations according to ward type

Error types per 100 observations	Community Hospital Wards	Psychiatric Wards
Expiry Error	5	5.7
Extra Dose	0.2	**0**
Formulation Error	0.2	0.8
Other reason	2.3	2.8
Almost not given	1.1	0.5
Given but unsigned	1.1	0.4
Omitted and unsigned	1.8	2.7
Omitted but signed	1.4	0.1
Unprescribed drug	0.1	0.2
Wrong dose	1	1.1
Wrong time error	3.1	0.8

The data was also examined in relation to the mode of administration. It can be seen from Table 3.41 that expiry errors were the most frequent type in wards that administered medication at the patient beside but prepared the medication in the clinic room, and wards using bedside-patient lockers as mode of administration, with 9.3 and 5.7 per 100 observations respectively. The second most frequent was different between these modes (bedside-prepared in clinic room and bedside-patient lockers) i.e. omissions (almost not given, omitted and unsigned and omitted but signed) were in bedside-prepared in clinic room mode with 3.5 per 100 observations and wrong time errors in bedside-patient lockers mode of administration with 5.1 per 100 observations.

In addition, the omissions were the most frequent error type in wards where the bedside-trolley mode of administration was used with 4.8 per 100 observations, and

expiry errors were second with 3.9 per 100 observations. Expiry errors and omissions were similar in mixed-bedside and queue modes of administration with 5.8 per 100 observations. The 'other reason' errors were the most frequent type in queue modes with 4 per 100 observations. Additionally, the expiry errors rate was higher in bedside-prepared in clinic room mode compared with the expiry errors rate in the other modes, and the omissions rate was higher in mixed-bedside and queue mode compared with omissions rate in other modes.

Finally, the wrong time errors rate was the highest in the bedside-patient lockers mode of administration compared with the wrong time errors rate in other modes, and there were no wrong time errors found in bedside-trolley mode of administration and mixed-bedside and queue mode of administration

Table 3.41: The type and the errors found per 100 observations according to mode of administration

Error types per 100 observations	Bedside - prepared in clinic room	Bedside - patient lockers	Bedside - trolley	Mixed - bedside and queue	Queue
Expiry Error	9.3	5.7	3.9	5.8	3.2
Extra Dose	**0**	0.4	**0**	**0**	**0**
Formulation Error	0.9	0.3	**0**	1.7	0.6
Other reason	1.7	2.6	1.8	0.8	4
Almost not given	0.6	0.5	2	**0**	0.6
Given but unsigned	0.9	1.4	0.6	**0**	0.2
Omitted and unsigned	2.6	2.1	1.2	5.8	2.1
Omitted but signed	0.3	1.3	1.6	**0**	**0**
Unprescribed drug	0.3	0.1	**0**	0.8	**0**
Wrong dose	0.3	0.8	1.4	1.7	1.5
Wrong time error	1.7	5.1	**0**	**0**	0.4

Table 3.42 shows the type and the errors found per 100 observations according to ward round time. Also, it demonstrates that the expiry errors were the most frequent type of errors at ward round time observed 08:00, 18:00 and 22:00 with 5.9, 5.8 and 3.2 errors per 100 observations respectively. At lunch round time 12:00 omissions (almost not

given, omitted and unsigned and omitted but signed) were the highest error type with 8.1 errors followed by expiry errors with 7.3 errors per 100 observations. The second most frequent type of error was related to omissions (almost not given, omitted and unsigned and omitted but signed) at evening round time 18:00 with 4.5 errors per 100 observations, and the omission and other reason was at night round time 22:00 with 2.2 errors per 100 observations. The WTE was the second highest error at morning round time 08:00 with 4.9 errors per 100 observations. In addition, there was no WTE detected in 12:00, 18:00 and 22:00 round time.

Table 3.42: The type and the errors found per 100 observations according to ward round time

Error types per 100 observations	08:00	12:00	18:00	22:00
Expiry Error	5.9	7.3	5.8	3.2
Extra Dose	**0**	**0**	**0**	0.5
Formulation Error	0.2	**0**	1.1	0.6
Other reason	2.8	2.6	2.4	2.2
Almost not given	1	1.5	**0**	0.8
Given but unsigned	0.2	1.8	**0**	1.8
Omitted and unsigned	1.5	4.8	3.4	1.4
Omitted but signed	1	1.8	1.1	**0**
Unprescribed drug	0.1	0.4	0.3	**0**
Wrong dose	0.6	1.8	1.6	1.1
Wrong time error	4.9	**0**	**0**	**0**

It can be seen from Table 3.43 that expiry errors were the most frequent type of errors found in all nurses' grade. Also, it shows that expiry errors and omissions (omitted and unsigned and omitted but signed) were the highest occurring errors with bank staff (10.9 per 100 observations), compared with other nurses grades. In addition, the chance of detecting some errors (formulation error, other reason errors, given but unsigned, omitted and unsigned and wrong time error) with band 5 nurses was slightly higher than the chance of detecting these errors with band 6 nurses.

However, the chance of detecting omissions (almost not given and omitted but signed) was slightly higher with band 6 nurses than the chance of detecting these errors with band 5 nurses. The chance of wrong time error was only detected with agency and band 5 nurses with 3.4 per 100 observations with agency and 2.4 per 100 observations with band 5 nurses, respectively.

Table 3.43: The type and the errors found per 100 observations according to grade or status of nurse

Error types per 100 observations	Band 5	Band 6	Bank	Agency
Expiry Error	4.7	5.3	10.9	6.8
Extra Dose	0.2	**0**	**0**	**0**
Formulation Error	0.6	0.2	**0**	0.3
Other reason	2.2	1.4	**0**	5.5
Almost not given	0.6	1.9	**0**	0.8
Given but unsigned	1.2	0.5	**0**	**0**
Omitted and unsigned	2.9	1.0	2.2	1.0
Omitted but signed	0.3	1.2	8.7	1.6
Unprescribed drug	0.2	**0**	**0**	**0**
Wrong dose	1.2	1.0	**0**	0.8
Wrong time error	2.4	**0**	**0**	3.4

Table 3.44 illustrates that expiry errors were the most frequent type of errors in non-psychiatric and psychiatric drug group 5.8 and 3.6 per 100 observations respectively, followed by omissions (almost not given, omitted and unsigned and omitted but signed). Also, it shows that the chance of detecting expiry errors, other reason errors, omissions (almost not given, omitted and unsigned and omitted but signed) and WTEs in non- psychiatric drug group was higher than the chance of detecting these errors in psychiatric drug group.

Table 3.44: The type and the errors found per 100 observations according to drug group

Error types per 100 observations	Non-psychiatric drug	Psychiatric drug
Expiry Error	5.8	3.6
Extra Dose	0.2	0
Formulation Error	0.2	1.1
Other reason	3.0	1.0
Almost not given	0.9	0.8
Given but unsigned	0.8	0.8
Omitted and unsigned	2.6	0.8
Omitted but signed	1.1	0
Unprescribed drug	0.1	0.2
Wrong dose	1.1	1.1
Wrong time error	2.4	1.1

Finally, as shown in Table 3.45 the highest error types were different between days observed. On Tuesday, Wednesday and Thursday the expiry errors were the main type of error with 6.1, 7.6 and 4.1 errors per 100 observations, respectively. On Monday, the WTEs were the highest type with 6.8 errors per 100 observations, and omissions on Friday with 8.5 errors per 100 observations.

The second highest type of error on Monday, Tuesday and Wednesday were the omissions with 4.4, 3.5 and 3.9 errors per 100 observations, respectively. On Thursday it was ‘other reason’ errors with 2.3 errors per 100 observations, and on Friday it was the expiry errors with 4.2 errors per 100 observations. Overall, there were no WTEs detected on Wednesday, Thursday and Friday.

Table 3.45: The type and the errors found per 100 observations according to ward round day

Error types per 100 observations	Monday	Tuesday	Wednesday	Thursday	Friday
Expiry Error	4	6.1	7.6	4.1	4.2
Extra Dose	**0**	**0**	**0**	0.6	**0**
Formulation Error	0.2	0.6	0.2	0.8	0.4
Other reason	2.7	2.2	3.2	2.3	2.3
Almost not given	0.6	0.6	0.9	**0**	3.5
Given but unsigned	1.1	1.2	0.6	0.8	**0**
Omitted and unsigned	3	2.5	1.9	1.3	2.3
Omitted but signed	0.8	0.4	1.1	0.2	2.7
Unprescribed drug	**0**	0.2	0.2	**0**	0.4
Wrong dose	0.4	1	1.1	1.9	0.8
Wrong time error	6.8	2.9	**0**	**0**	**0**

3.2.3 The MAEs potential for harm

After the MAEs were recorded the potential for harm was judged and rated by the researcher, and one of the Trust clinical pharmacists and agreement gained through a meeting as suggested by (Haw and Cahill, 2011). Figure 3.19 shows that 27% of total MAEs found were judged to have had the ability to potentially harm the patient. Table 3.46 demonstrates the number of potential for harm errors in CHWs and PWs. In addition, Table 3 in Appendix 13 shows different types of potential harm that were found.

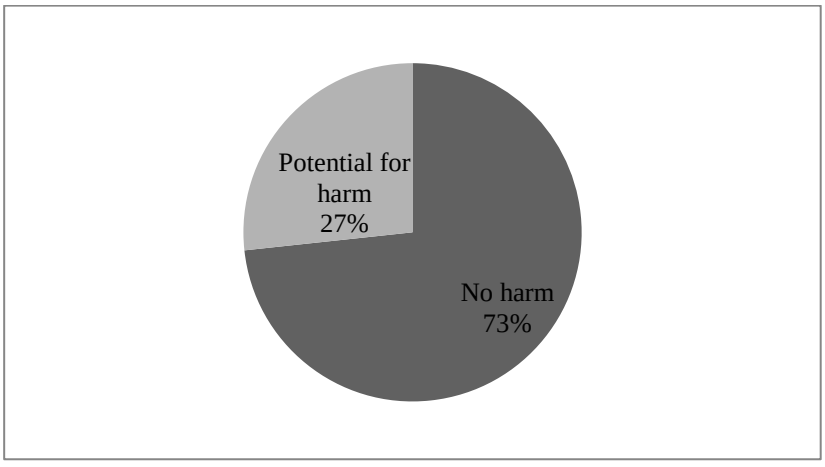

Figure 3.19: The % of potential for harm

Table 3.46: The number of potential for harm errors in CHWs and PWs

Potential for harm	CHWs	PWs
Yes	64	34
No	153	116

Overall, the descriptive data analysis revealed several meaningful ways of expressing the findings. This was conducted by describing different categories individually that were related to the study objectives. The total number and average of OEs was shown followed by the number of MAEs, the total and mean error rates.

The chapter also included the contributing factors and other variables that were examined separately. The type and frequency of MAEs, and finally, the MAEs' potential for harm were also examined. Table 3.47 summarise the significant findings in CHWs and PWs.

Table 3.47: Breakdown of some MAEs finding in CHWs and PWs

	CHWs		PWs	
Error types per 100 observations	Expiry Error	5	Expiry Error	5.7
	Extra Dose	0.2	Extra Dose	0
	Formulation Error	0.2	Formulation Error	0.8
	Other reason	2.3	Other reason	2.8
	Almost not given	1.1	Almost not given	0.5
	Given but unsigned	1.1	Given but unsigned	0.4
	Omitted and unsigned	1.8	Omitted and unsigned	2.7
	Omitted but signed	1.4	Omitted but signed	0.1
	Unprescribed drug	0.1	Unprescribed drug	0.2
	Wrong dose	1	Wrong dose	1.1
	Wrong time error	3.1	Wrong time error	0.8
Number of MAEs according to drug group	Non-psychiatric drug	208	Non-psychiatric drug	104
	Psychiatric drug	9	Psychiatric drug	46
Potential for harm	Yes	64	Yes	34
	No	153	No	116
Mean MAE rate % according to	Band 5	16.8%	Band 5	19.5%

grade or status of staff	Band 6 Bank Agency	14.7% 21.7% 22.3%	Band 6 Bank Agency	14.9% 0 11.2%
Mean MAE rate % according to mode of Administration	Bedside-patient lockers Bedside-trolley	20.6% 14.1%	Bedside-prepared in clinic room Mixed-bedside and queue Queue	18.6% 20.8% 16%

Furthermore, to investigate the reliability of the relationships between numbers of potential contributing factors with probability of increasing the risk of MAEs, inferential statistical data analysis was conducted using Poisson Regression Model (PRM). This is explained in more detail below.

3.3 Inferential statistical data analysis

This section presents the statistical model used to determine the "best" combination of predictors (contributing factors) with regard to the occurrence of MAEs. There are different potential models under the broad class of regression approaches known as Generalized Linear Models (GzLM) encompassing logistic regression, Poisson regression and negative binomial regression (Cohen et al., 2013, Hayat and Higgins, 2014).

One of the distinct features of the data is that it measured the occurrence of MAEs by counting them. According to Long and Freese (2014), count variables which record how many times an event has happened can be studied using the classic Linear Regression Model, but the estimates can be inconsistent or inefficient, and attributable to a number of modelling violations. In this case, models based on the Poisson distribution are deemed to be more applicable, leading to the Poisson Regression Model (PRM). The Poisson Regression Model, a member of the GzLM family, is suitable for

modelling count variables that measure the frequency of very rare and random events (Cohen et al., 2013).

The Poisson Regression Model has been used to investigate the relationship between a dependent count variable Y, e.g. number of errors, and a set of predictor variables or X-variables, also known as explanatory variables. It can also be used to describe interactions between predictor variables. The inclusion of terms in the model, to explain the variation in Y, may be judged using significance testing (McCullagh and Nelder, 1989 as cited by Cohen et al., 2013).

3.3.1 Poisson regression model (PRM)

The Poisson Regression Model is usually reserved for modelling count data, as described above, and is viable and efficient as an alternative modelling approach to classic linear regression. Also, the PRM avoids log transforming of the dependent count variable, which can be problematic with zero values in Linear Regression. More generally it avoids awkward inverse transformations. Historically, a PRM has been commonly used to analyse frequency of events in the form of a rate for selected unit of exposure (Hayat and Higgins, 2014).

In particular, PRMs have been used to model the number of events that happen in specific periods of time according to a set of explanatory variables. One of the advantages of the PRM, and statistical modelling in general, is it allows a time effect to depend on the levels of other explanatory variables and vice versa, i.e. interaction affects can be incorporated (Millsap and Maydeu-Olivares, 2009).

To define a Poisson Regression Model, suppose we have a count observation, yi, on a dependent Poisson random variable Yi for i = 1 to n. Then the expected count (true

mean), μ_i, corresponding to each Poisson random variable may be modelled on values of explanatory variables, $x_{1i}, x_{2i}, \ldots, x_{ki}$ as follows:

$$\mu_i = \exp(\beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki})$$

Where the regression coefficients $\beta_0, \beta_1, \ldots, \beta_k$ are unknown parameters. This defines the classic PRM within the GzLM framework, where the effect of an explanatory variable may be described in terms of a ratio of means, simply referred to as a relative risk from now on (Kutner et al., 2004, Long and Freese, 2014).

Moreover, medication error data usually have a positively skewed distribution with a low mean. The distribution typically has a large number of small counts starting at zero and a rapidly decreasing number of higher counts. These data frequently follow a Poisson distribution. Hence, a PRM can be considered as one possible approach to the modelling of medication error counts (Hutchinson and Holtman, 2005 as cited by Chang, 2007).

For a Poisson distribution, the mean and the variance are equal. A specific violation of this is commonly referred to as over-dispersion, which occurs when the variance is greater than the mean (under-dispersion occurs less frequently). Over-dispersion may be the source of lack-of-fit of a Poisson Model to a dataset. In such cases, there are a number of remedial approaches, including the use of negative binomial regression (Bharti, 2008), and quasi-likelihood methodology (Agresti, 2003).

Overall, both Poisson and negative binomial regression models are generally used to analyse count data (Coxe et al., 2009). The difference between the two models is in the mean and variance; where the Poisson Regression imposes equality of mean and variance, the negative binomial regression model allows the variance to be greater than the mean, making it well-suited for modelling over-dispersed data (Berk and

MacDonald, 2008, Hilbe, 2011, Piza, 2012). Goodness-of-fit of Poisson Regression Model to the MAE data is considered further later on.

3.3.2 Estimation and model selection

The method of maximum likelihood estimation (MLE) was used to fit Poisson Regression Models (McQuade and Gromova, 2015), using the GENLIN command in SPSS (version 21) (IBM Crop, 2012). The significance of explanatory terms was assessed using likelihood ratio tests at the 5% significant level (Bharti, 2008, Long and Freese, 2014). Wald tests were also used when practically convenient.

In this study, all explanatory variables (contributing factors) (i.e. wards type, time of medication administration round observed, whether the nurse was interrupted or not, mode of administration, whether the drug administered was a psychiatric drug or not, number of patients in the round, number of opportunity of error in the round, day of mediation administration round observed, whether the ward busy with other activity or not, shortage of staff, nurse grade or status, nurse gender, rout of administration, and drug frequency including PRN) were considered in the Poisson modelling and their significance tested. Predictors were included in the final model if they were statistically significant (p-value ≤ 0.05). Variables were removed if they were not statistically significant (p-value > 0.05) in the presence of other predictors included in the model.

3.3.3 Findings

3.3.3.1 PRM for the total errors found

A preliminary Poisson Regression analysis demonstrated four explanatory factors have a statistically significant association with the making of errors: (1) whether the nurse was interrupted when drug was being given or not; (2) time of medication

administration round observed; (3) the mode of drug administration; and (4) whether the drug administered was a psychiatric drug or not, see Table 3.48.

Table 3.48: Explanatory factors selected in Poisson regression modelling and adjusted likelihood ratio test results

Explanatory factor	Likelihood ratio test statistic	df	*p*-value
Whether the nurse was interrupted or not	14.720	1	**<0.001**
Time of day observed	9.750	3	**.021**
Mode of administration	13.390	4	**.010**
Psychiatric drug or not	10.666	1	**.001**

Because the explanatory factors are categorical it is convenient to utilise a reference constraint when reporting the fitted Poisson Regression Model. Table 3.49 presents estimated regression coefficients associated with each level of an explanatory factor apart from a selected reference category where the regression coefficient is constrained to be zero. Hence, for specific explanatory factors, the exponential of an estimated regression coefficient is comparing that respect category to the reference, via a ratio of means (relative risk).

A relative risk greater than one suggests an increased risk of MAEs, Wald tests are also presented. The results in Table 3.49 illustrate that interrupting the nurse during drug administration significantly increases the risk of MAEs by 86% (*p*-value <0.001).

Also, it shows that time of day 08:00 and 12:00, when drug administration takes place are associated with significantly increased risk of MAEs relating to 22:00. The increased risks are (44% and 65% respectively).

Furthermore, mode of administrations bedside-prepared in clinic room, bedside-patient locker, and mixed between bedside and queuing administration mode are significantly

different from drug trolley mode of administration with corresponding increased risk of (65%, 61%, and 71% respectively).

Moreover, the queuing mode of administration is not significantly different from drug trolley mode of administration. Finally, the type of drug is significantly associated with MAEs, with non-psychiatric drugs resulting in an increased risk of (66%).

Table 3.49: Fitted PRM corresponding to Table 3.48

Explanatory term	Regression coefficient	S.E.	95% Profile likelihood CI		Wald test			Relative risk =exp(regression coefficient)	95% Profile likelihood CI for relative risk	
			Lower	Upper	Test statistic	df	*p*-value		Lower	Upper
Intercept	-2.904	.2234	-3.352	-2.476	169.021	1	**<.001**	-	-	-
Nurse interrupted or not										
Nurse was interrupted	.622	.1508	.316	.909	17.030	1	**<.001**	1.864	1.372	2.481
Nurse was not interrupted	0[a]	.	.	.	.	.	.	1	.	.
Time of day										
Time of day 08:00	.367	.1446	.089	.656	6.459	1	**.011**	1.444	1.093	1.927
Time of day 12:00	.500	.1774	.149	.846	7.934	1	**.005**	1.648	1.161	2.331
Time of day 18:00	.238	.1790	-.115	.588	1.769	1	.183	1.269	.891	1.800
Time of day 22:00	0[a]	.	.	.	.	.	.	1	.	.
Mode of administration										
Bedside-prepared in clinic room administration mode	.498	.1869	.130	.865	7.084	1	**.008**	1.645	1.139	2.375
Bedside-patient locker administration mode	.476	.1516	.184	.779	9.848	1	**.002**	1.609	1.202	2.180
Mixed between bedside-prepared in clinic room and queuing administration mode	.537	.2646	-.005	1.038	4.112	1	**.043**	1.710	.995	2.823
Queuing administration mode	.249	.1865	-.117	.615	1.783	1	.182	1.283	.889	1.850
Bedside-trolley administered mode	0[a]	.	.	.	.	.	.	1	.	.
Drug group										
Non-Psychiatric drug	.504	.1601	.198	.826	9.933	1	**.002**	1.656	1.219	2.285
Psychiatric drug	0[a]	.	.	.	.	.	.	1	.	.

[a] Reference constraint

The statistical modelling has so far ignored possible interactions between explanatory factors, where the effect of one factor is modified by another, and concentrated on a main effects model where overall effects of explanatory factors are considered. According to Chang (2007), most medication errors depend on combinations of factors, which suggest the inclusion of interaction terms in the Poisson Regression may improve it. On adding pair-wise interaction terms (between explanatory factors) into the PRM Table 3.48, only the interaction between interruption and time of day was statistically significant (p-value = 0.015).

The nature of the interaction between interruption and time of day was investigated by examining the relative risk of MAEs when nurses were interrupted versus when not interrupted at different times of the day. These relative risks, from the fitted Poisson Regression Model, are provided in Table 3.50. Clearly, the only statistically significant comparisons are at 12:00 and 22:00 when interruptions are associated with increased risk of MAEs; 2.05 and 3.83 times the non-interruptions respectively. There is also weak evidence (p-value = 0.059) of increased MAEs risk at 18:00 with a relative risk of 2.15.

Table 3.50: Relative risk of MAEs when interrupted versus not for different time of day

Time of day	Relative risk of MAE (ratio of means) for interrupted nurse vs. not	df	Wald test p-value	95% Wald CI for relative risk	
				Lower	Upper
08:00	1.07	1	.820	0.62	1.84
12:00	2.05	1	**.016**	1.14	3.68
18:00	2.15	1	**.059**	0.97	4.75
22:00	3.83	1	**<.001**	2.19	6.68

On examining the estimated relative risks in Table 3.50 further, there is an increasing trend across the day. On comparing these relative risks across time of day the only statistically significant change is between 08:00 and 22:00 (p-value $\leq$ 0.001), with the earlier time having a relative risk 72% lower. The goodness-of-fit of the above was initially examined using PRM by comparing the sample mean and variance of the MAEs counts cross-tabulated by the

explanatory factors in Table 3.48. These sample statistics were roughly comparable in value which is consistent with the Poisson assumption.

Further, to allow for extra-Poisson variability in the above models two alternative models were fitted with the same explanatory terms. The first was a negative binomial regression and the second a PRM utilising a robust estimator of the covariance matrix of regression coefficients. Both of these models lead to the same practical conclusion as those derived from using Poisson Regression. Hence, there is no clear evidence against the use of Poisson Regression for modelling the MAEs data.

3.3.3.2 PRM for procedural errors Vs clinical errors

The total errors (367) found were then classified to *clinical* errors (174) and *procedural* errors (193) as shown in Figure 3.20. PRM was used to investigate separately any combination of the contributing factors with regard to increasing the risk of *clinical* errors or *procedural* errors.

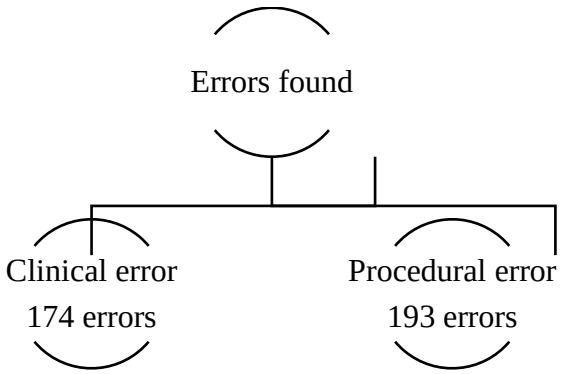

Figure 3.20: Error classification

The Poisson Regression analysis demonstrated two explanatory factors have a statistically significant association with the making of *procedural* errors: (1) the mode of drug administration; and (2) whether the drug administered was a psychiatric drug or not (Table 3.51). In addition, three explanatory factors have a statistically significant association with the making of *clinical* errors: (1) time of medication administration round observed; (2) the mode of drug administration; and (3) nurse grade or status (Table 3.52).

Table 3.51: Explanatory factors selected in Poisson regression modelling and adjusted likelihood ratio test results (procedural errors)

Explanatory factor	Likelihood ratio test statistic	df	*p*-value
Mode of administration	13.059	4	**.011**
Psychiatric drug or not	15.306	1	**<0.001**

Table 3.52: Explanatory factors selected in Poisson regression modelling and adjusted likelihood ratio test results (clinical errors)

Explanatory factor	Likelihood ratio test statistic	df	*p*-value
Time of Day observed	19.958	3	**<0.001**
Mode of administration	20.306	4	**<0.001**
Nurse grade or status	13.769	3	**.003**

The results in Table 3.53 shows that mode of administrations bedside-prepared in clinic room and bedside-patient lockers are significantly different from drug trolley mode of administration with corresponding increased risk of procedural errors by (136% and 54%, for the first two, respectively). Moreover, the mixed administration mode and the queuing mode of administration are not significantly different from drug trolley mode of administration. Lastly, the type of drug administered is significantly associated with procedural errors, with non-psychiatric drugs resulting in an increased risk of 2.3 times the psychiatric drugs.

Table 3.54 illustrates that the time of day 08:00 and 12:00, when drug administration takes place are associated with significantly increased risk of clinical errors compared to 22:00. The increased risks are 2.5 and 2.4 times respectively. Further, bedside-patient lockers and mixed mode of administrations are significantly different from queuing administration mode with corresponding increased risk of 2.4 and 2.7 times respectively. Moreover, the drug trolley and bedside-prepared in clinic room mode of administration are not significantly different from queuing mode of administration. Finally, the band 6 and agency nurses staff are significantly different from band 5 nurses staff in terms of association with clinical errors, with a lower risk of (47% and 43% respectively). There is no significantly difference between error rates of bank nurses and band 5 nurses.

Table 3.53: Fitted PRM corresponding to Table 3.51 (procedural errors)

Explanatory term	Regression coefficient	S.E.	95% Profile likelihood CI		Wald test			Relative risk =exp(regression coefficient)	95% Profile likelihood CI for relative risk	
			Lower	Upper	Test statistic	df	*p*-value		Lower	Upper
Intercept	-3.549	.2832	-4.126	-3.013	157.111	1	**<.001**	.	.	.
Mode of administration										
Bedside-prepared in clinic room administration mode	.858	.2423	.386	1.340	12.553	1	**<.001**	2.359	1.471	3.819
Bedside-patient locker administration mode	.431	.2139	.022	.864	4.057	1	**.044**	1.539	1.022	2.372
Mixed between bedside-prepared in clinic room and queuing administration mode	.229	.3981	-.622	.961	.332	1	.565	1.258	.537	2.613
Queuing administration mode	.461	.2489	-.026	.954	3.428	1	.064	1.586	.974	2.596
Bedside-trolley administered mode	0[a]	.	.	.	.	.	.	1	.	.
Drug group										
Non-Psychiatric drug	.825	.2254	.399	1.286	13.403	1	**<.001**	2.282	1.491	3.619
Psychiatric drug	0[a]	.	.	.	.	.	.	1	.	.

[a] Reference constraint

Table 3.54: Fitted PRM corresponding to Table 3.52 (clinical errors)

Explanatory term	Regression coefficient	S.E.	95% Profile likelihood CI		Wald test			Relative risk =exp(regression coefficient)	95% Profile likelihood CI for relative risk	
			Lower	Upper	Test statistic	df	*p*-value		Lower	Upper
Intercept	-3.508	.2489	-4.023	-3.045	198.663	1	**<.001**	.	.	.
Time of day										
Time of day 08:00	.897	.2238	.471	1.352	16.052	1	**<.001**	2.452	1.601	3.864
Time of day 12:00	.885	.2708	.352	1.419	10.690	1	**.001**	2.424	1.422	4.133
Time of day 18:00	.514	.3044	-.089	1.110	2.854	1	.091	1.672	.915	3.035
Time of day 22:00	0[a]	.	.	.	.	.	.	1	.	.
Mode of administration										
Bedside-prepared in clinic room administration mode	.232	.2899	-.344	.799	.639	1	.424	1.261	.709	2.223
Bedside-patient locker administration mode	.860	.2340	.412	1.334	13.503	1	**<.001**	2.363	1.511	3.795
Bedside-trolley administered mode	.304	.2915	-.272	.876	1.088	1	.297	1.355	.762	2.402
Mixed between bedside-prepared in clinic room and queuing administration mode	1.009	.3822	.231	1.740	6.964	1	**.008**	2.742	1.259	5.699
Queuing administration mode	0[a]	.	.	.	.	.	.	1	.	.
Nurse grade or status										
Band 6	-.638	.2469	-1.145	-.173	6.677	1	**.010**	.528	.318	.841
Bank	.470	.5440	-.698	1.476	.747	1	.387	1.600	.498	4.373
Agency	-.556	.2250	-1.011	-.126	6.102	1	**.014**	.574	.364	.882
Band 5	0	.	.	.	.	.	.	1	.	.

[a] Reference constraint

It can be seen from the above inferential statistical findings that the PRM demonstrated a number of contributing factors which have a statistically significant association with the occurrence of errors; whether the nurse was interrupted when drug was being given or not, time of medication administration round observed, the mode of drug administration and whether the drug administered was a psychiatric drug or not. Overall, there were interrelations between these contributing factors which increased the risk of MAEs. However, these contributing factors were slightly different when the errors were separated to procedural errors and clinical errors.

3.4 Summary

This chapter has analysed the main findings of the MAEs quantitatively. These findings have been considered by employing descriptive and inferential statistics. The descriptive statistics are the total number and average of OEs, the number of MAEs and the total and mean error rates, type and frequency of MAEs and MAEs potential for harm. The inferential analysis using PRM examines statistically verifiable relationships between the number of errors found and a number of potential contributing factors, Table 3.55 summaries the main findings of the descriptive and the inferential statistics, which will be discussed in Chapter 5.

The findings show that the expiry errors, is a major component of procedural errors, take place across both psychiatric and community hospital ward types, specifically when medication is given at the patient bedside and is prepared either in the clinic room or given via patient lockers. The findings also suggest that omissions, a major component of clinical errors, were associated with the mixed mode of administration on psychiatric wards and the 12:00 administration time. Another type of clinical error was the wrong time error which was associated mainly with the patient lockers and the

08:00 administration time. The results suggest that patient lockers are not as safe as perceived because they are implicated in both clinical and procedural errors. It now remains for the researcher to develop an understanding of why these errors occur and how they might be addressed. Therefore, the next chapter will qualitatively analyse the researcher's observational notes and the semi-structured interviews to add context and to gain the healthcare professional (nurses and pharmacists) opinions about the causes behind MAEs found.

Table 3.55: The main findings of the descriptive and the inferential statistics

Descriptive Findings	Inferential Statistics Findings
• MAEs rate include WTEs 16.4%, MAEs rate exclude WTEs 14% and MAEs rate exclude procedural error 7.7% • The average OEs for CHWs higher than PWs, with similar mean error rate 18% • The highest average OEs was in (CHW9, CHW3 and CHW2) • The lowest average OEs (PW3 and PW5) • The highest mean error rate was in (PW8, CHW1, PW3 and CHW2) • The lowest mean error rate was in (PW1, PW10 and CHW6) • The highest average OEs (08:00 and 22:00) • The highest mean error rate (12:00) • The highest average OEs was in band 6 • The mean error rates for nurse grade not statistically significant • The OEs of non-psychiatric higher than OEs of psychiatric • The error rates of non-psychiatric higher than error rates of psychiatric • The OEs observed with no interrupted nurse higher than the OEs observed with interrupted nurse • The error rate higher with interrupted nurse than error rate with no interrupted nurse • The average OEs was lowest at bedside-prepared in clinic room • The mean error rate for mode of administration not statistically significant • Expiry errors were most frequent of MAE type with 32% followed by omission with 32% • Omission was most frequent type when excluding the procedural error • WTEs more in (CHW1, CHW2 and CHW9) using bedside-patient lockers • Expiry errors were the most frequent type in patient bedside prepared in the clinic room and bedside-patient lockers • Omission was the most frequent error type in bedside-trolley • Expiry errors rate was higher in bedside-prepared in clinic room compared to the other modes, and the omission rate was higher in mixed-bedside and queue mode compared to other modes • Expiry errors were most frequent type of errors at (08:00, 18:00 and 22:00) • Omission was the highest error type for (12:00) • WTEs only found at (08:00) • Expiry errors were the most frequent type of errors found in all nurses' grade • Expiry errors and omission were the highest-occurring errors with bank • The chance of WTEs were only detected with agency and band 5 • The chance of detecting omission was slightly higher in band 6 nurses than band 5 • 27% of total MAEs found were judged to have had the ability to potentially harm the patient	**1- PRM for the total errors found** • Interrupting the nurse during drug administration significantly increases the risk of MAEs by 86% • Time of day 08:00 and 12:00 are associated with significantly increased risk of MAEs 44% and 65% • Bedside-prepared in clinic room, bedside-patient locker, and mixed between bedside and queuing administration mode are significantly increased risk of MAEs 65%, 61%, and 71% • Non-psychiatric drugs resulting in an increased risk of 66% **2- PRM for procedural errors found** • Bedside-prepared in clinic room and bedside-patient locker are significantly different from drug trolley mode of administration with increased risk by 136% and 54% • Non-psychiatric drugs resulting in an increased risk of 2.3 times the psychiatric drugs **3- PRM for clinical errors found** • 08:00 and 12:00 significantly increased risk of clinical errors by 2.5 and 2.4 times respectively compared to 22:00 • Bedside-patient locker and mixed mode of administrations are significantly increased risk of 2.4 and 2.7 times queuing administration mode • Band 6 and agency nurses staff are significantly different from band 5 nurses staff in terms of association with clinical errors, with a lower risk of 47% and 43% respectively

Chapter 4 Qualitative Findings

4.1 Introduction

This chapter presents the qualitative interpretation of the observational notes and interview transcripts. The key findings from the quantitative work outlined in Chapter 3 are summarised here. The contributing factors for clinical errors were found to relate to the time of the medication administration round observed (with morning and lunchtime rounds increasing the risk of MAEs), the mode of drug administration (with bedside-patient lockers and mixed between bedside administration when prepared in clinic room and queuing both increase the risk of MAEs) and the nurse grade or status (with band 5 nurses increase the risk of MAEs). The contributing factors for procedural errors were found to relate to the modes of drug administration (bedside-patient lockers and bedside administration when prepared in clinic room) but also it was found that non-psychiatric drugs increased the risk of MAEs. The present chapter aims to provide an interpretation of these findings. The purpose of the researcher was to first examine their own observational notes to provide a systematic interpretation of the causes of the observed MAEs. Then nurses and pharmacists were interviewed about their experience of MAEs in general and their views about specific cases relating to the observations made in order to gain their view about the reasons behind these MAEs. These interviews views were then compared with the data from the researcher observation notes.

4.2 Qualitative data

For the qualitative data analysis (for both the observation notes and interviews), the researcher adopted a codifying process based on thematic analysis. Thematic analysis was carried out because it provides a way of organising qualitative interview data in the

form of themes: recurrent topics, ideas or statements identified across the corpus of data. Thematic analysis also allows for these themes to be mapped against a theoretical framework within a deductive approach. The framework of the adapted organisational accident causation model was used to identify the themes and make sense of the data. Each transcript extract (e.g. part of a sentence) was coded with words or sentences against elements of the adapted organisational accident causation model.

4.2.1 The observational notes

As described in Chapter 2, the researcher made detailed observational notes during each visit to a ward. These notes were personal reflections about the general setting of the ward and specific notes about why MAEs occurred and what may have contributed to the errors (see Appendices 11 and 12). These notes had been made throughout and the researcher coded the notes retrospectively using thematic analysis. The main aim of the analysis was to group together specific types of errors (e.g. expiry errors) and to provide an interpretation of why these errors had occurred against the coding framework. The researcher notes transcript was given a code, RN.

4.2.2 The interviews

The semi-structured interviews were completed with eight nurses (three community hospital wards nurses, three psychiatric wards nurses and two lead nurses) and four pharmacists as previously described. Each interview transcript was given a code, e.g. PWN1, PWN2 etc. for the psychiatric wards nurses; CWN1, CWN2, etc. for community wards nurses, LN for lead nurses and PH1, PH2 etc. for the pharmacists. Table 4.1 and Table 4.2 demonstrate more information about participants' interviews. The researcher then analysed the responses of the nurses and pharmacists using

thematic analysis and according to specific MAE types (see Appendix 12). Table 4.3 presents the main categories and codes used for the thematic analysis.

Table 4.1: Participants nurses interviews' information

Participant	Gender	Grade	Profession	Setting of work	Usual ward type working
CWN1	Female	Band 5	Administered nurse	CHWs	CHWs
CWN2	Female	Band 5	Administered nurse	CHWs	CHWs
CWN3	Female	Band 5	Administered nurse	CHWs	CHWs
PWN1	Female	Band 5	Administered nurse	PWs	PWs
PWN2	Female	Band 5	Administered nurse	PWs	PWs
PWN3	Female	Band 5	Administered nurse	PWs	PWs
LN1	Female	-	Lead nurses	PWs	CHWs and PWs
LN2	Female	-	Lead nurses	CHWs	CHWs

Table 4.2: Participants pharmacists interviews' information

Participant	Gender	Profession	Setting of work	Usual ward type working
PH1	Male	Clinical pharmacist	CHWs and PWs	CHWs
PH2	Female	Clinical pharmacist	PWs	PWs
PH3	Male	Clinical pharmacist	CHWs and PWs	PWs
PH4	Female	Clinical pharmacist	PWs	CHWs and PWs

Table 4.3: Codes and categories for the observation notes and interviews

Category	Codes	Quotes from observation notes or interviews as examples
Active failure	Slips	*"The nurse was attempting to give 1 gm instead of 750 mg"*
	Lapses	*"I think just forgetting possibly"*
	Rule-based mistake	*"Because you're discussing things with patients when they come in and you're just giving them a bit of time"*
	Knowledge-based mistake	*"Not many of them are aware that we have to put a date on"*
	Situational violation	*"Because it's not careful. I think, it's just like a routine, keep doing that"*
	Exceptional violations	*"Sometimes people sign because they have to make sure that they don't leave blank boxes"*
	Routine violations	*"The nurses believe the patient has taken it and the nurse isn't actually administering it themselves"*
Error-producing condition	Staff workload (interruptions, distractions, ward pressure etc.)	*"Maybe it's the rush, like pressure or something"*
	Lack of knowledge	*"Probably lack of education"*
	Miscommunication (drug chart not clear) Miscommunication (between carer and nurse)	*"The charts that when, they need to be really clear. Quite often doctors scribble things out or whatever"*

	Patient attitude	*"But it depends on the nature of our patients"*
	Inexperience nurse	*"Some of them like the newly graduated students, sorry nurses"*
	Nurse attitude	*"It's surely a misconduct, they shouldn't do this"*
Latent condition	Safety culture and priorities	*"I think that's not talked about enough, so it's not pressed in to people's minds"*

4.3 Observation notes and interviews findings

The data collected by the researcher through their observational notes and the transcripts of the 12 semi-structured interviews were analysed against the adapted organisational accident causation model (Taylor-Adams and Vincent, 2004) which has been previously described as originating from Reason's model of organisational accidents (Reason, 1997). The purpose of using this framework was to identify people's perceptions about the main causes of the procedural and clinical errors through categorisation as active failures, error-producing conditions and latent condition. This model provides a helpful structure for the analysis and has been used by others (Dean et al., 2002, Taxis and Barber, 2003a). Table 4.4 presents the categorisation of errors as procedural versus clinical. Figure 4.1 shows the thematic map underpinning the analyses of the observation notes and the interviews.

Table 4.4: The framework used to complete analysis of different error types

Category	Type of error	Accident Causation
Procedural errors	Expiry error	Active failure category – i.e. slips, lapses, violation, mistake etc. Error-producing condition Latent condition
	Given but unsigned	
	Other reason	
Clinical errors	Omitted and unsigned	Active failure category – i.e. slips, lapses, violation, mistake etc. Error-producing condition Latent condition
	Omitted but signed	
	Almost not given	
	Wrong time error	
	Wrong dose	

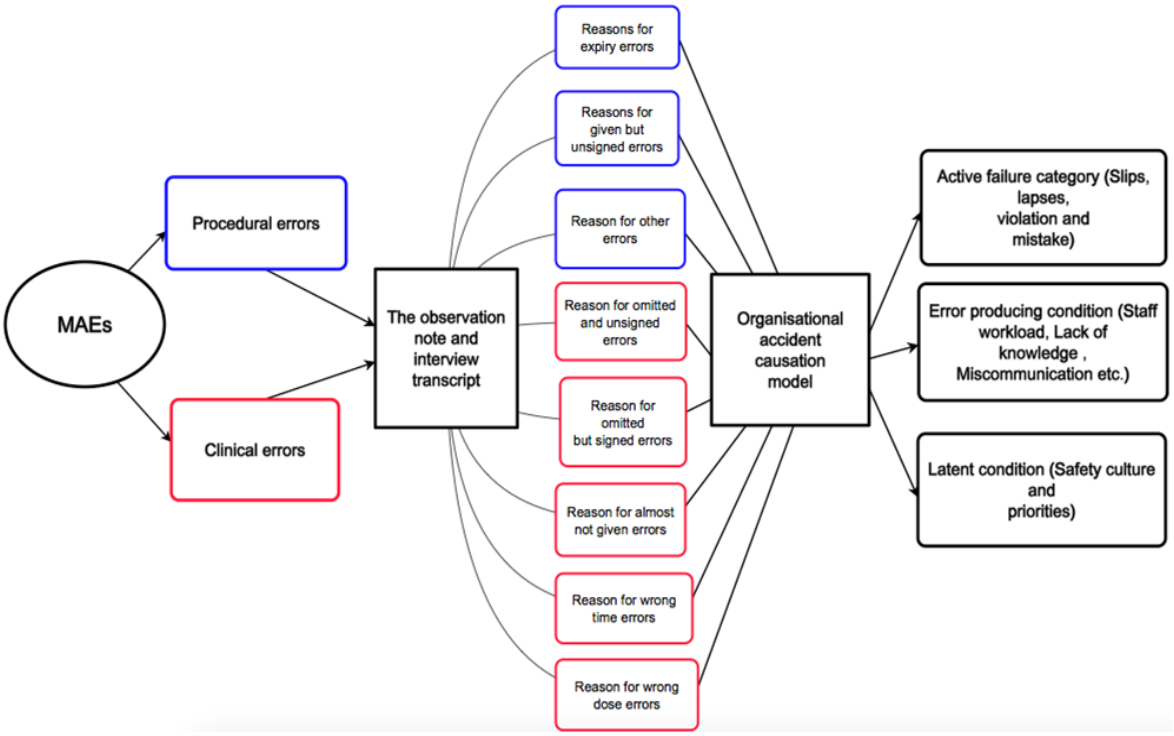

Figure 4.1: The thematic map for analysis of the observation notes and the interviews

4.3.1 Procedural errors

4.3.1.1 Reasons for expiry errors

When *expiry errors* were made, the active failure was categorised by the researcher during the medication administration rounds as a situational violation in the main. This means that most, if not all, of the expiry errors were deemed by the researcher to have been actions based on conscious decisions by the nurses to not comply with the rules about checking expiry dates or rules about writing the date when a new package is opened. Situational violations are non-compliance with the rules due to situation-specific factors such as time pressure and workload. For example, the researcher noted:

> *"The nurse obtained an insulin pen from the fridge and gave it to the patient. This is because the patient regularly takes this medication and had their own supply stored in the fridge. When I checked to see if there was a label on the insulin pen to indicate when it has been opened and therefore when it might expire, I did not find this label. I think this error happens because some nurses maybe think that the medication might be used up before it expires." RN*

In this example, the researcher thinks the main cause of expiry errors is situational violation due to the conversation with the nurses during observation about writing the opening date of the insulin label, where the nurse said *"The insulin is already labelled with the dispensing date and the medication might be used up before it expires."* This means that the nurse gave a rationale for their action, clearly showing they knew they were not adhering to the rules, making this a situational violation. Another example:

> *"The nurse obtained an insulin pen from the fridge and gave it to the patient. This is because the patient regularly takes this medication and had their own supply stored in the fridge. The nurse was interrupted by the patient. When I checked to see if there was a label on the insulin pen to indicate when it has been opened and therefore when it might expire, I did not find this label. I think this error happens because some nurses noted that some of medications will be removed or relabelled by the pharmacy department." RN*

Also, in this example the researcher thinks about the reason of expiry errors due to the conversation with the nurse during observation about writing the opening date of the insulin, the nurse said *"It is the pharmacy department responsibility and the pharmacy technician will remove or relabel the insulin."* In this situation the researcher found that most of the nurses were aware of the procedure of checking expiry dates or rules about writing the date when a new package is opened due to many of such medications observed. However, some nurses did not follow this procedure during the observation which identified by the researcher as situational violation; from the conversation with the nurses and sometimes from the action made by nurse when checking the medication. For example, the nurse only check the dispensing label and the quantity of medication when they opened liquid bottle without writing the opening date label. This is due to time pressure and workload. Indeed, the researcher interpreted the error-producing conditions for expiry errors as relating mainly to staff workload based on the observations made (e.g. interruption from other staff and some of the patients, ward pressure or skill mix). For example for the skill mix:

> *"During the insulin administration most of the nurses were doing other thing such as checking the patient blood glucose level." RN*

In addition, the researcher's opinion about the latent condition at play related to the safety culture and priorities as a part of the organisational and management factors. In the researcher's opinion, the Trust needs to train their nurse staff to increase their belief about the safety culture and how to reduce the interruptions, how to organise their tasks, and how to separate their priorities during administration. Also, some wards need to be more organised to allocate the staff in the right place during administration round to reduce work pressure, reducing interruptions and to ensure a suitable skill mix.

In contrast, the interviews with the nurses revealed a very different view about the reasons for expiry errors. Nurses explained expiry errors as errors of omission or knowledge-based mistakes. That is, during the interviews most of the nurses described expiry errors in the context of *forgetting* to check the expiry date or forgetting to write the opening date of a newly-opened medication package. Or they reported that perhaps some nurses are not actually aware of what the rules are in relation to expiry errors. For example, one nurse interviewee noted:

> *"That, I think that one, it was, it's probably Gaviscon bottle, it's a full big bottle, when you're opening that one you asking, patient is asking for ten ml Gaviscon, you're getting that one and giving it straight to the patients and you're not staying there to write the date and time on there at the time so then you forget." CWN1*

Lack of knowledge was identified by the nurses as an additional error-producing condition, in addition to staff workload already identified by the researcher. The researcher related staff workload to safety culture and priorities, the interviewees also related staff workload and lack of knowledge to the safety culture and priorities. For example, one nurse showed that the nurses need a better safety culture to know this type of error:

> *"I think that's not talked about often enough, about those little things like expiry dates and writing when things have been opened. I think that's not talked about enough, so it's not pressed in to people's minds that that's something you need to be doing on a regular basis, whenever you open anything new. I think we don't, probably don't discuss that enough in terms of medicines management." PWN1*

The pharmacist interviews indicated a somewhat similar view with the nurses about the reasons for expiry errors. Pharmacists described expiry errors as knowledge-based mistakes. That is, during the interviews most of the pharmacists described expiry errors in the context of nurses not being trained, or not familiar about putting the opening and expiry date label onto products. Or they reported that perhaps some nurses do not know at all what the rules are in relation to expiry errors. For example, one pharmacist interviewee noted:

> *"Because I don't think the nurses are familiar with the process, they're not familiar about putting the expiry date on when they're opening up liquid medicines; they're not familiar at all. So, they're not aware of it, I would say, yeah." PH3*

On the other hand, one pharmacist indicated situational violations as a possible active failure category. During the interview, the pharmacist stated expiry errors occurred in the context of the nurse considering the date opened and expiry dates as not important and deciding not to write the opening and expiry date because they know the pharmacist will come and write the date opened.

In addition, another pharmacist viewed expiry errors as errors of omission and explained in the interview that the nurses forget to write the date opened and expiry dates; the pharmacist noted:

> *"They don't know that they've got to do it for that medicine. Because it's not for every medicine they don't know which ones they do have to do it to and they don't remember to do it." PH4*

Following on from these explanations of expiry errors, lack of knowledge was identified by the pharmacists as an error-producing condition, one pharmacist stated:

> *"I know what you are saying but in real life sometimes people don't do that but it will be good so it should be done but it's not and a lack, is the key, it's the training, it's not been done. We should teach, it's a good point." PH1*

Also, staff workload was identified by only one of the pharmacists:

> *"Because they have thousands of other bits of information to remember and trying to remember everything is impossible." PH4*

Lack of knowledge was identified by the nurses, in addition to staff workload which was also identified by the researcher. The pharmacist and nurses related staff workload and lack of knowledge to the safety culture and priorities. For instance, one pharmacist expressed that nurses need different skills to be familiarised with and to remind them to write the date:

> *"I think you need posters, training sessions, reminders, but something has to be at the product level where the nurses are using it to remind them to do it. So, you would have a blank sticker on it that says, date opened, expiry date, which they then fill in because it's a visual reminder on the packet for them to do it." PH4*

Another pharmacist said:

> *"We should and say, oh look you haven't write it, it's wrong." PH1*

(Figure 4.2).

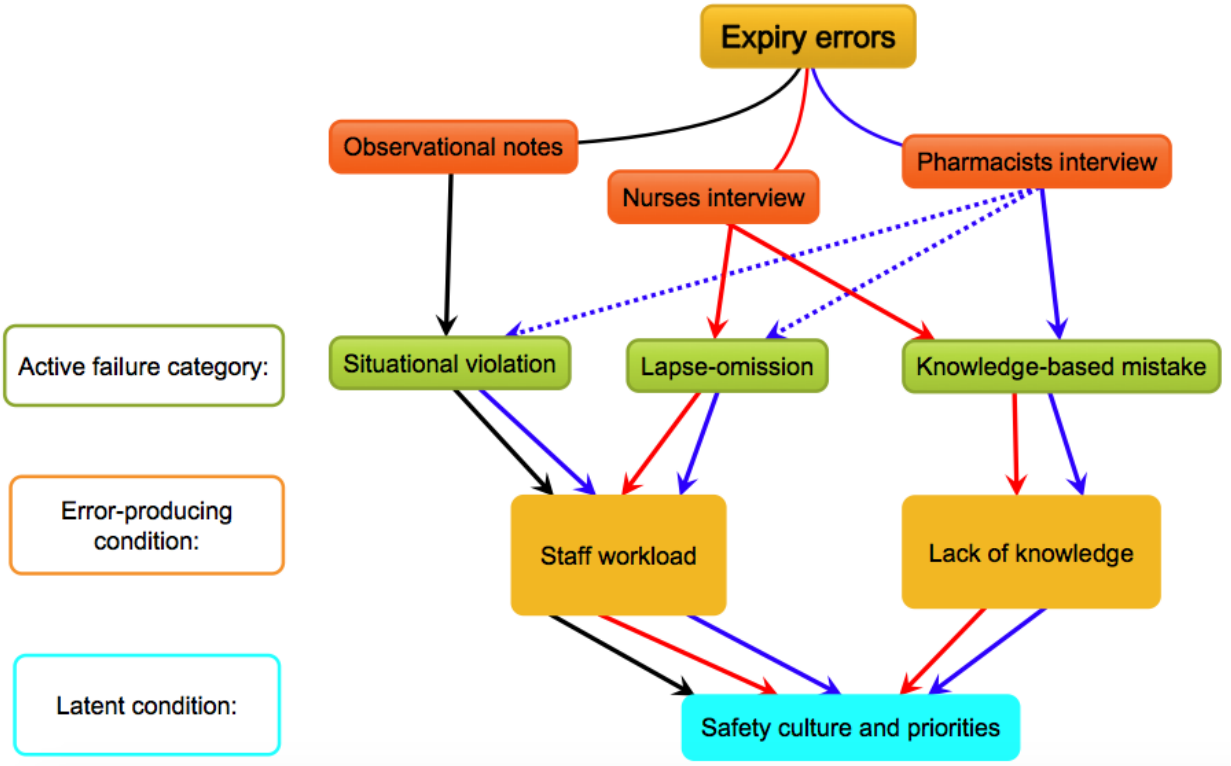

Figure 4.2: Consolidation of observational notes, nurses' and pharmacists' interviews for the reason of expiry errors

4.3.1.2 Reasons for given but unsigned errors

During the medication administration rounds when nurses *gave the medication and left the box blank*, the active failure was categorised as an omission by the researcher. This means that most of these errors were believed by the researcher to have been actions not as planned and occurred because the nurses forgot to sign the box. For example, the researcher noted:

> *"The nurse obtained the tablet from the patient's locker and gave it to the patient. This is because the patient regularly takes this medication and had their own supply stored in their locker. However, as the round was moving quickly I noticed that the nurse didn't sign the box on the chart to indicate that this was given. I think this error happens because some nurses under the pressure of time, and they forget to sign the box which is not happened occasionally in this ward." RN*

Lapse omission is a short-term memory lapse resulting in forgetting to do what you are meant to do. Based on the observations made, the researcher deduced that the error-producing conditions for this type of procedural errors were relating mainly to staff

workload (e.g. work pressure or interruptions). For instance in relation to work pressure:

> *"The nurse under pressure, many medications for administration today and the nurse wants to finish on time." RN*

Additionally, the researcher also judged that the latent condition related to the safety culture and priorities where the nurses have some difficulties to control the interruptions as well as not being very familiar in terms of dealing with blank boxes, and some wards need to be more organised to minimise work pressure and interruptions.

The nurse's view about the reasons for given but unsigned errors was very similar to the researcher's viewpoint. During the interview, most of the nurses thought that forgetting to sign the drug chart box was an omission mainly due to different error-producing condition such as staff workload and patient attitude. For example, one nurse interviewee noted:

> *"Yeah, rushing, time, you've got to, if you give it then you've got to sign it straight afterwards. But if someone distracts you, or the next person's already come in and you put it away and say, oh, I'll do that later. It's not, yeah, you've got quite a big chance of just forgetting then I think." PWN1*

Another example relating to workload is where one nurse said:

> "*I think because the ward's busy and we get distracted, too many people want a bit of us at the same time.*" *PWN2*

Another nurse stated that:

> *"Some patients they do like before breakfast, some they like after breakfast, yeah. Then I don't know how you're going to resolve that problem." CWN2*

The researcher related staff workload to the safety culture and priorities, the nurses also related staff workload but in addition patient attitude to the safety culture and priorities (the nurses' double-checking culture, and to be more focused in the administration round). For example, one nurse stated:

> *"Well, I think it's nurses who are doing the drug round having one, proper dedicated time to do the drug round but two, having understanding of the implications of their actions, or omissions." LN1*

In another example, a nurse said:

> *"When starting doing medication rounds that's what they should be focused on, nothing else. That's what should happen." PWN2*

The pharmacists indicated a similar view to the researcher and the nurses about the reasons for given but unsigned errors. Pharmacists explained this error as an omission. Most of the pharmacists, if not all, said that nurses forget to sign because of staff workload (e.g. interruption or distraction). Two of the pharmacists added situational violation as reasons one pharmacist said that some nurses *"not being careful enough" PH1* and the other pharmacist stated that some nurses *"not following the flow procedure" PH2* due to workload (distraction). The error-producing conditions were again relating to staff workload. For example, one pharmacist interviewee noted:

> *"They get distracted. Someone interrupts them, they get distracted. The patient asks them a question and the person just gets distracted and moves on to the next thing. The phone goes, someone, it's usually interruptions that cause that one." PH4*

Furthermore, most of interviewed pharmacists related staff workload to the safety culture and priorities as the latent condition. For example: one pharmacist stated:

> *"Finding a way of not just getting so the nurses don't have distractions and interruptions. The nature of the psych ward means that its quite hard for them not to be interrupted, double checking each other, having two people always there for administration." PH2*

(Figure 4.3)

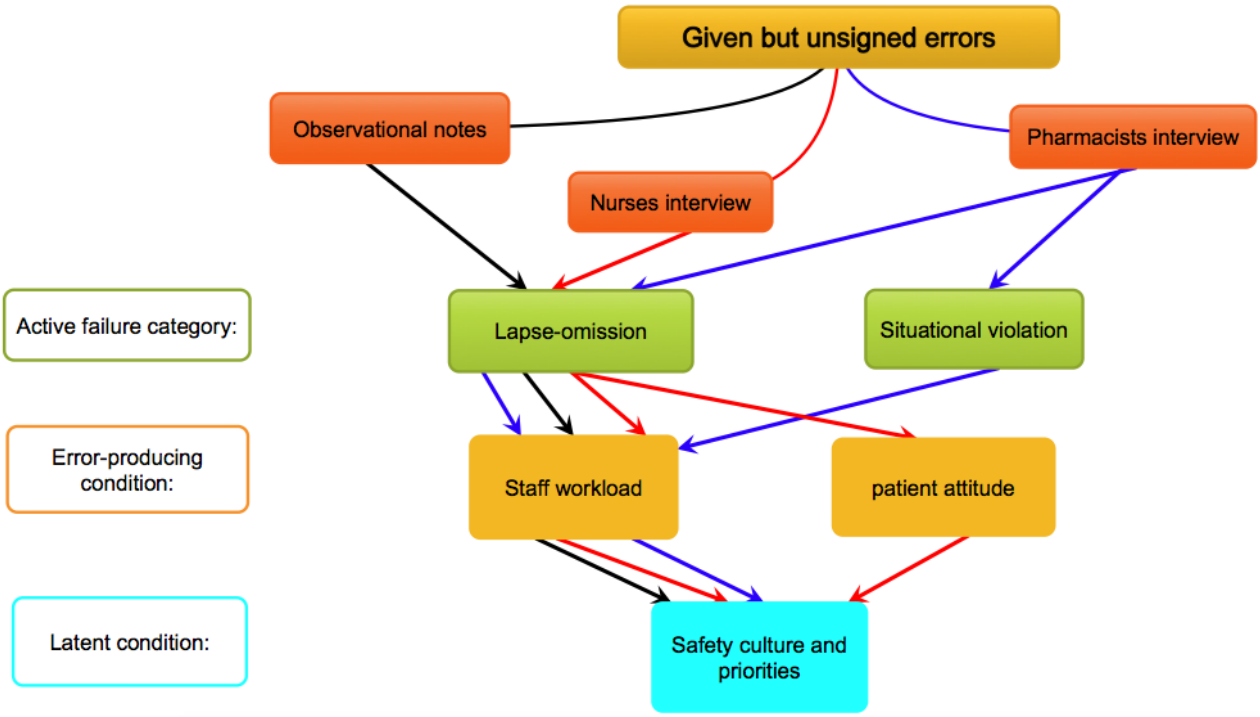

Figure 4.3: Consolidation of observational notes, nurses and pharmacists' interviews for the reason of given but unsigned errors

4.3.1.3 Reason for other errors

For the '*other reason'* errors, the active failure was categorised by the researcher mainly as situational violation. Also, the researcher believed that most of the identified 'other reason' errors were based on conscious decisions by the nurses to not comply with the rules about following the drug usage instructions. In this situation, the researcher discovered that a situational violation is the main active failure of other reason errors (such as rinsing mouth after using corticosteroid inhaler or did not dissolve the dispersible tablet in small amount of water etc.) from the conversation with the nurses and sometimes from an action made by the nurse during observation. For example, the researcher noted:

> *"The nurse obtained the corticosteroid inhaler and gave it to the patient. This is because the patient regularly takes this medication and had their own supply stored in clinic room. However, I noticed that the nurse didn't ask the patient to rinse their mouth after the use as the ward pharmacist pointed at the drug chart. I think this error*

> *happens because some nurses might find that unnecessary to follow the drug usage instructions." RN*

In this example, during the conversation with the nurse about the rinsing mouth after using the corticosteroid inhaler the nurse said *"The patient has been using the inhaler from long time ago and he/she is familiar with the inhaler use."*

The researcher interpreted the error-producing conditions for 'other reason' errors as relating to staff workload (e.g. work pressure or skill mix issues) based on the observations made. In addition, the researcher's perspective about the latent condition related to the safety culture and priorities where some wards need to allocate the staff in the right place during administration round to reduce work pressure, and to ensure suitable skill mix.

However, the interviews with the nurses highlighted a different view to this about the reasons for other errors. Most of the nurses talked about reasons for other errors mainly as knowledge-based mistakes, then some as situational violation, but also rule-based mistakes and omissions. That is, during the interviews most of the nurses described other errors as follows. In the context of not telling the patient to rinse their mouth after using the corticosteroid inhaler as an example, they reported that perhaps some nurses are not actually aware of what the usage instructions are, they do not pay attention, they think that patients are already aware of the advice, or they forget to tell the patients what the right instructions are. For example, one nurse interviewee said:

> *"There is a queue of people waiting, the patient has got other medication that they are taking other than the tablets, I mean the inhaler. I have seen it written but not always. Ok, maybe, perhaps I am not paying attention, Ok. Definitely education because I wasn't even aware of that myself." PWN3*

Following on from these explanations of other errors, lack of knowledge was identified, perhaps unsurprisingly, by most nurses as an error-producing condition for knowledge-

based mistakes. This was followed by staff workload for omissions and situational violations. For example, one nurse interviewee said:

> *"Staff are just too busy. And the nature of our patients sometimes, you get distracted. And, I don't know, because normally they get water with their medications."PWN2*

Also, patient attitude for situational violations as well as rule-based mistakes were other error-producing conditions cited by the nurses. The nurse interviewees related staff workload, patient attitude, and lack of knowledge to the safety culture and priorities as latent conditions. For instances, one nurse stated:

> *"I think rather than, over the, the whole thing about medication is about allowing enough time for nurses to focus and not be distracted and that would be throughout all of them, but I think with those two it's more around competency." LN2*

Another nurse noted:

> *I think some nurses would be surprised what the huge variety of errors that you can make and what is classed as an error. I think if we had information about that it would make people think. So I think that, more awareness or knowledge of that, would be good." PWN1*

The pharmacist interviews showed an almost similar view with the nurses about the reasons for other errors. Pharmacists indicated other errors arose due to knowledge-based mistakes and omissions. That is, during the interviews most of the pharmacists described other errors in the context of nurses forgetting or not being aware about providing instructions to patients. For example, one pharmacist interviewee said:

> *"Yes, and I suspect that is probably due to lack of knowledge of the consequences and also lack of experience of the consequences, so they may still know that they should and they may know why, but actually they've never seen anyone with oral thrush from it. So, probably, with no experience, they'll say I know we're meant to, but really? I've never seen anyone have a consequence from it, so possibly that's how it's happened." PH2*

Additionally, inexperienced nurses, and miscommunication between the pharmacists and nurses were identified by some pharmacists as error-producing conditions, in

addition to staff workload, lack of knowledge which were also identified by the nurses. An example in relation to the staff workload is shown here where one pharmacist noted:

> *"I think that probably happens quite routinely, the nurses probably will forget to tell the patient. I think it's because the nurses are also distracted." PH3*

The interviewee pharmacists related all these error-producing condition to the safety culture and priorities as latent conditions. For example, one pharmacist said:

> *"Yes, perhaps giving them more training and also making sure they're not distracted when they're giving medicines." PH3*

Another pharmacist said:

> *"Ensuring instructions are on the prescription and training people to understand the importance of the instructions. And, writing the instructions that people can read them." PH4*

(Figure 4.4)

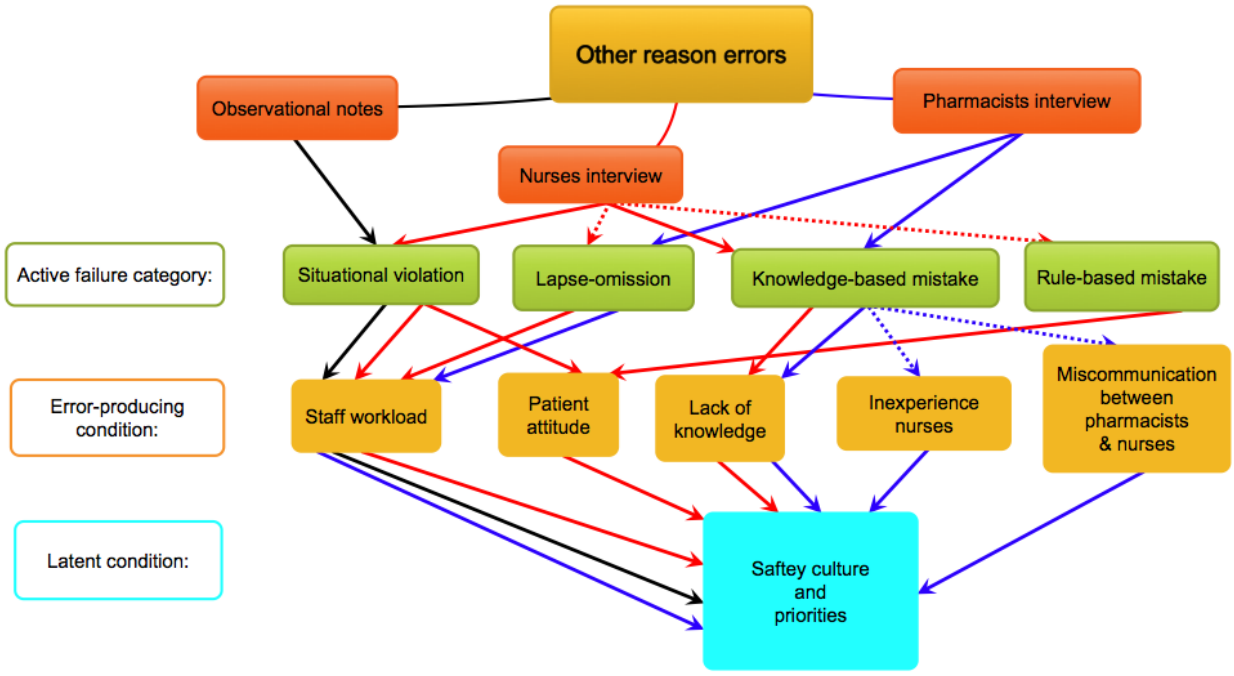

Figure 4.4: Consolidation of observational notes, nurses and pharmacists' interviews for the reason of other errors

4.3.2 Clinical errors

4.3.2.1 Reason for omitted and unsigned errors

During the medication administration rounds when nurses *omitted the medication and the charts remained unsigned,* the active failure was categorised as an omission by the researcher. This means that most of the errors were believed to have been actions not as planned that were based on nurses forgetting to give the medication and leaving the box on the administration chart blank. For example, the researcher noted:

> "*The cream is one of the patient regularly medication and had their own supply stored in clinic room. However, I noticed that the nurse forgot to get the cream and give it to the patient. There was another patient interrupt the nurse. I was waiting until the nurse end with the patient but the nurse still forgot to give and left the box blank. I think this error happens because some nurses were confused from the complicated drug charts and was interrupted." RN*

Based on the observations made, the researcher inferred the error-producing conditions for this type of clinical errors as relating mainly to staff workload (e.g. ward pressure, interruptions or skill mix) and miscommunication (drug chart order not being clear). Additionally, the researcher interpreted the latent condition as relating to the safety culture and priorities where the nurses have some difficulties controlling the interruptions, as well as separating their priority during administration. Also, nurses were not quite familiar dealing with omissions and how to solve miscommunication. In addition, some wards need to allocate their staff in the right place during administration rounds to decrease the work pressure, reduce interruptions and to ensure suitable skill mix. More or less similar latent conditions were found by the researcher in other clinical errors below.

Most of the nurse's views about the active failure category for these errors were similar to the researcher's opinion (i.e. as omissions). In addition, situational violation was suggested as an active failure category of this error by one of the nurses. Throughout the interviews most of the nurses referred to this error as forgetting to administer the

medication and forgetting to sign the drug chart box or that the medication was deemed to not be needed due to different error-producing conditions such as written miscommunication (drug chart order not clear), staff workload, miscommunication between carer and nurse, patient attitude and inexperienced nurses. For example, about written miscommunication one nurse interviewee stated:

> *"Omissions might happen if perhaps the patient refuses to take the medication and you forget to put the refused sign or sometimes it happens because there is, the patient has a lot of medication and sometimes things are crossed out, so it's you're looking through and then you might not realise that something hasn't been crossed out because maybe there's something above has been crossed out, something below has been crossed out, so it's just a matter of perhaps not looking properly and seeing that it's not been crossed out." PWN3*

In another example relating to staff workload, other nurse said:

> *"I've seen charts sometimes that are just, you look at it and it's, and just the time and space to do medication properly. Sometimes you feel a bit rushed by the other pressures on the ward and you want to get it done as quickly as possible."PWN1*

One of the lead nurses had a similar view with other nurses that workload and miscommunication between carer and nurse were the error-producing conditions behind the omission and unsigned errors, however, this participant pointed out that omission of some topical drugs such as E45 cream was due to prescribing errors:

> *"So, to me, something like E45 is actually it's a prescribing error, because it should be prescribed PRN rather than at set times." LN1*

The researcher had related staff workload and miscommunication (drug chart order not clear) to the safety culture and priorities, and similarly the nurses related the error-producing condition to the safety culture and priorities. For example, one nurse interviewee showed the need for two nurses' availability in administration instead of one nurse:

> *"Always two staff administering medication and one person should really be checking what the other's administering rather than two of us doing different medications at the same time, which does happen." PWN1*

Another nurse said:

> *"Yeah, so we as an organisation have had a missed medicines not administered problem over quite a considerable amount of time. I don't think we're that unusual but we have, and so what should happen now is, is at the end of each shift, so as part of your nurse in charge responsibilities, is that you should do a blank box audit at the end of the shift." LN1*

Likewise, the interviews with the pharmacists indicated a similar view with the researcher and the nurses about the reasons for omitted and unsigned errors. Some pharmacists explained this error as an omission and a situational violation due to some nurses forgetting to administer, or thinking it is not necessary. One of the pharmacists added rule-based mistake as a reason due to some nurses maybe using their own judgement for not giving the medication. For example, one pharmacist said:

> *"So in terms of the topical preparation itself, this is quite, sometimes people don't look at it, the topical preparation as a medicine." PH3*

All of the pharmacist interviewees identified that staff workload were the main error-producing conditions and some added patient attitude and lack of knowledge. For example, one pharmacist interviewee noted the staff workload:

> *"It is important to understand what type of error it is because if it's E45 cream that is forgotten has minor importance than to give, for example, Flucloxacillin which is an antibiotic so it's very important to know what you are missing because it can happen that a cream can be missed but Flucloxacillin definitely it's very important. It should be investigated. Mostly because nurses have difficult life in the wards and sometimes humanly they forget to sign." PH1*

Furthermore, the pharmacists also related the staff workload, patient attitude and lack of knowledge to safety culture and priorities as the latent condition. One pharmacist stated:

> *"Ward managers need to ensure that nurses have enough time to give medication also that they don't get disturbed while they give medication." PH1*

In another example, another pharmacist said that:

> *"I think it's about raising the profile and raising the seriousness of it, but I think it possible has to come from the nurses themselves, or from senior nursing staff rather than from pharmacy, because it's a bit like we're just policing them." PH2*

(Figure 4.5)

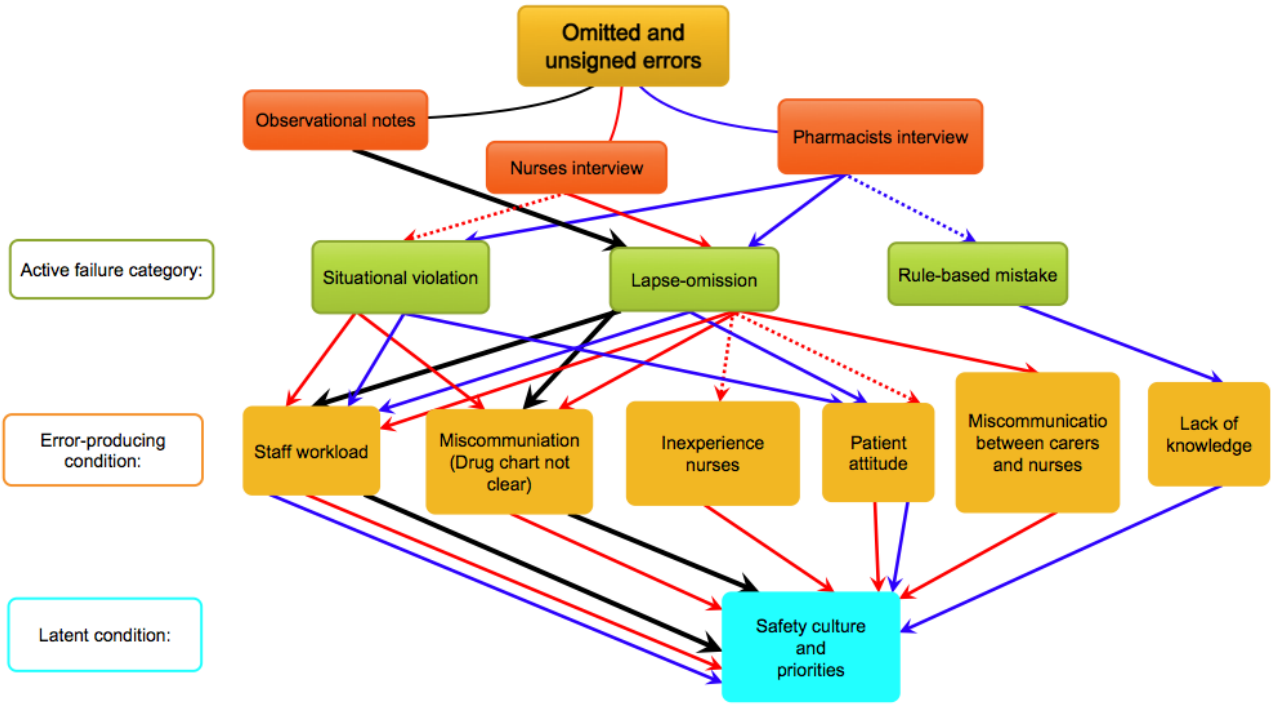

Figure 4.5: Consolidation of observational notes, nurses and pharmacists' interviews for the reason of omitted and unsigned errors

4.3.2.2 Reason for omitted but signed errors

When *omitted but signed errors* were made during the medication administration rounds the active failure was categorised by the researcher as a situational violation or a lapse omission. This means that the omitted but signed errors were believed by the researcher to be based on conscious decisions by some nurses to not comply about giving the medication or forgetting to give it (while signing the drug chart). For example, the researcher noted:

> *"The cream is one of the patient regularly medication and had their own supply stored in the trolley. However, I noticed that the nurse did not get the cream from the patient's medication container and give it to the patient. I was waiting until the nurse end with the patient but the nurse still did not give and the box on the chart signed which indicated that this was given. I think this error happens because of the work environment: the nurse could be under pressure to finish the round on time." RN*

This situation was repeated many times during the observation, and when the researcher asked the nurses in a side conversation about signing the drug chart without giving the medication (specially the topical medication), some psychiatric ward nurses said *"oh,*

sorry I forgot to give the medication, the chart is not clear, I confused between this drug and the one crossed above" and other nurses said that *"it is busy ward, we have many patients today, the carer or patients applied the cream after the morning bath"* without double-checking with them. The researcher thought of the error-producing conditions for omitted but signed errors as relating to staff workload (e.g. nurse under pressure to finish the round time or being interrupted) and miscommunication (drug chart order not clear) based on the observations made. Furthermore, the researcher's view about the latent condition was that these related to the safety culture and priorities.

The nurse interviews returned a very similar view as the researcher's about the reasons for omitted but signed errors. Nurses clarified thought of these errors as a situational violation or omission. That is, during the interviews most of the nurses described omitted but signed errors in the context of forgetting to apply the topical medication or dependence on another carer to apply it, as an example. For instance, one nurse interviewee noted:

> *"With creams that's, as I said earlier if the nurse would probably say I will do it after your wash because if they do it and then they wash it, they'll wash it off something like that or could say, could be like tell the carer when you wash the patient can you apply this, but they don't. So, for me personally I would do it myself, I would make sure that I would do it myself and not tell anyone to do it themselves." CWN3*

During the nurse interviews staff workload was recognised as an error-producing condition. For instance, lead nurse stated:

> *"Workload, I mean the workload, there is a list of things, tasks that need to be done at the end of the day." LN2*

Also, miscommunication between carer and nurse, patient attitude and inexperienced nurses were identified as other error-producing conditions. The interviewees related these error-producing conditions to the safety culture and priorities. For example, one nurse explained:

> *"It's actually about ensuring that qualified nurses have the time to do the drug round appropriately, without distractions and be able to follow through on things." LN2*

Another nurse said:

> *"I think just education really, just education and pointing it out to people if they are doing it, supervision maybe." PWN3*

The pharmacists' interviews presented a different view to the researcher and nurses regarding the reasons for omitted but signed errors. Pharmacists thought of these errors as errors of exceptional violation, slips, knowledge-based mistakes, situational violations and routine violations. During the interviews, most of the pharmacist described omitted but signed errors in the context of some nurses signing the drug chart just to make sure not to leave blank boxes, *"Pop all the medicines out and sign everything without looking" PH2*, poor practice, relying on patients to self-administer or getting in the habit of signing boxes. For example, one pharmacist interviewee noted:

> *"I would have thought it's where the nurses believe the patient has taken it and the nurse isn't actually administering it themselves. They're expecting the patient to administer it and therefore they're signing it in the part of the drug, and they're signing it going yeah, the patients had it. But they may or may not have checked properly whether the patient has actually had it or not. People get in the habit of signing boxes. They just go down the list and sign them all." PH4*

In addition, nurses' attitude, inexperienced nurses, lack of knowledge, staff workload and miscommunication between patients and nurses were identified by the pharmacists as the error-producing condition. An example for staff workload, one pharmacist stated:

> *"Because obviously, as I explained before, it's like they're working in a distracting environment which is high pressurised. And also, when it comes to topical medicine, as I said, it's very grey, isn't it, because you, you're relying on patients, it's not very, whereas with the tablets and things like injections, there's a point of starting, you're getting the medication and then you're administering it. Whereas, with topics you're sometimes relying on patients to self-administer. So you sign for it saying that, oh, the patient's going to self-administer possibly." PH3*

The pharmacists related all those error-producing conditions to the safety culture and priorities. For instance, one pharmacist said:

"Well, I've been told, and I don't know if this is true that nurses are not taught at university or when they, how to administer medicines, they learn on the job as student nurses, so they learn from each other, so if they learn from someone with a poor practise, then that is what they'll do. We have created a flow chart for how to administer medicines, but I somehow doubt that they use it, or that they think it's important because they're professionals in their own right and they do it the way they want to do it, but I suppose pointing out the error that happens from doing it that way, maybe that will help." PH2

(Figure 4.6)

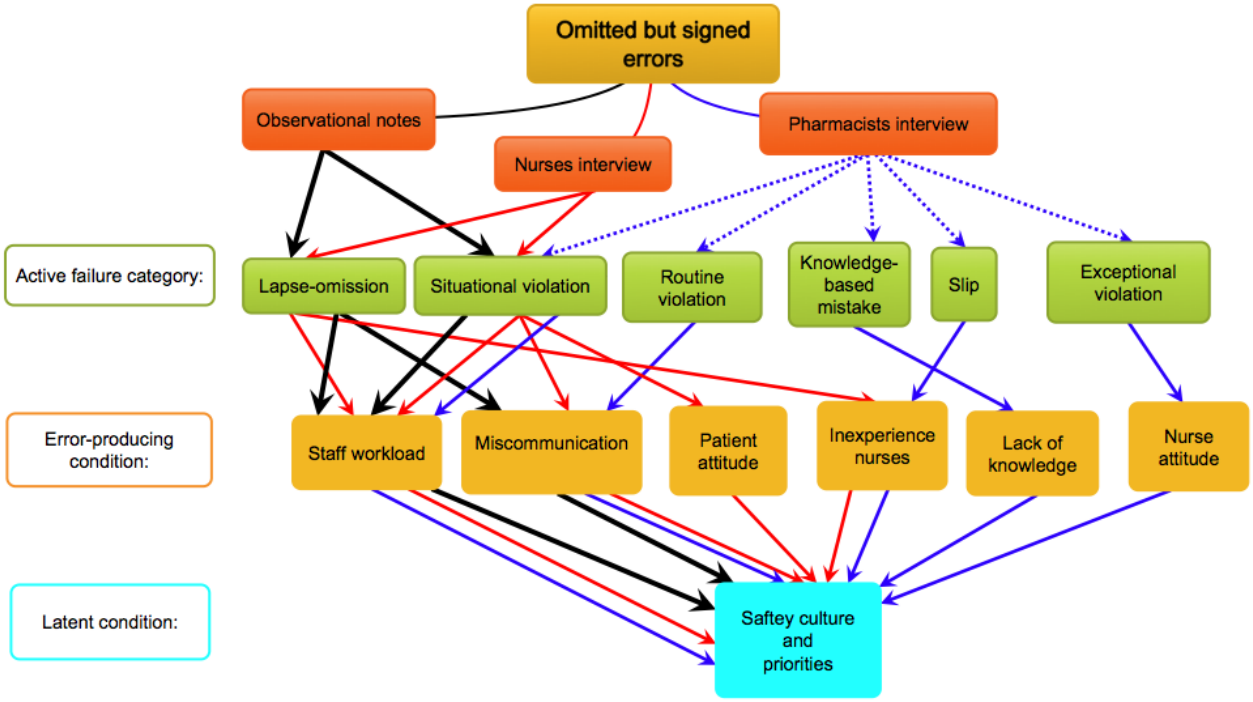

Figure 4.6: Consolidation of observational notes, nurses and pharmacists' interviews for the reason of omitted but signed errors

4.3.2.3 Reason for almost not given errors

For *almost not given errors*, the active failure was categorised as an omission by the researcher during the medication administration rounds. This means that most of these errors were believed by the researcher to have been based on nurses forgetting to give the medication the first time (before being reminded by the researcher). For example, the researcher noted:

"This tablet is one of the patient regularly medication and had their own supply stored in clinic room. However, I noticed that the nurse forgot to get the tablet from the cupboard and give it to the patient. The patient interrupts the nurse. I was waiting until the nurse finished giving all patient other medication and still forgot to give the tablet.

> *In this time, I Intervene and remind the nurse to give this drug. I think this error happens because some nurses were interrupted during the drug administration or confused from the complicated drug chart." RN*

Also, the researcher found that the error-producing conditions for almost not given errors related generally due to staff workload (e.g. nurse interrupted during the drug administration) and miscommunication (drug chart order not clear). Additionally, the researcher inferred that the latent condition related to the safety culture and priorities.

The nurses' point of view was similar to the researcher's about the almost not given errors. Most of the nurses during the interviews referred to this error as forgetting to administer the medication due to different error-producing conditions such as staff workload, patient attitude and inexperienced nurses. For example, one nurse interviewee noted:

> *"When you've got 27 people to do medication for I suppose it's quite easy to forget to go back to someone. Again, it's about being organised. Don't put the chart away, because you haven't given it yet. Keep it out. Yeah, work demands and pressure I think usually." PWN1*

Another nurse stated about the workload:

> *"Because of busyness of the ward, interruptions, again you could be going to do something someone else calls you with something else." PWN3*

The nurse interviewees related the different error-producing conditions again to the safety culture and priorities as a latent condition. One nurse said:

> *"I think we need to be given more time to do it in a proper way. I'll quite often just take it to them just so that they've had it, and remind them, you really do need to come to the clinic for your medication. We've got a lot of people, we can't go round to everyone's rooms, but I've brought it this time." PWN1*

Another nurse noted that they need "*More staff really. I doubt that they will." CNW2*

Moreover, the interviews with the pharmacists indicated a similar view with the researcher and the nurses about the reasons for almost not given errors. Most of the pharmacists explained this error as an omission. They described that nurses forget to

administer the medication because of staff workload and patient attitudes as error-producing conditions. One pharmacist added knowledge-based mistakes as reasons that some nurses do not look properly at the drug chart and related that to lack of knowledge and miscommunication between the doctors and nurses. One pharmacist interviewee noted:

> *"I think they must, they might have got distracted or interrupted, I know you looked at that about why that might have happened, or there might have been a second chart or they couldn't find something, they moved on and they forgot to go back and look at it again, yes I'm sure it can happen. Interruptions, distractions, busy, psychiatric wards, depends which ward it was, was it CHS wards or psychiatric wards, but they're very busy, stressful environments and I think the nurses just have a lot of interruptions and a lot going on that they have to do." PH2*

Furthermore, most of the interviewed pharmacists related the error-producing conditions to safety culture and priorities as the latent conditions. One pharmacist mentioned that:

> *"Methods again I suppose, so if a patient isn't up, maybe there is somewhere that you put the chart, separated, so we know that person still needs to have the medication, maybe it's written on a whiteboard. Maybe on the whiteboard in the nurse's office, they're highlighted to say this person hasn't had their morning medicine so that all the nursing staff know, so I think it's just about methods that are consistently followed." PH2*

Another pharmacist said:

> *"I think, as I said before, having those two nurses so that, if there is something distracting, then there is one nurse who will be able to follow it and allow the other nurse to on with the medication." PH3*

(Figure 4.7)

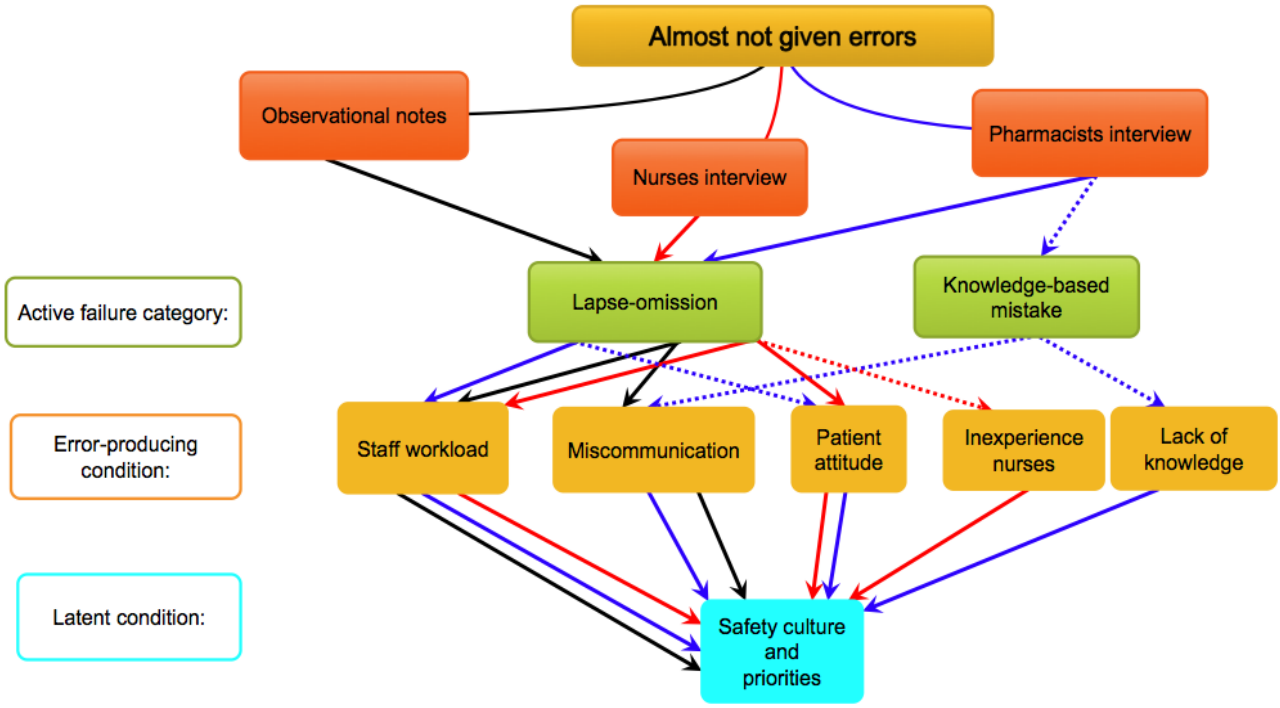

Figure 4.7: Consolidation of observational notes, nurses and pharmacists' interviews for the reason of almost not given errors

4.3.2.4 Reason for wrong time errors

During the medication administration rounds, the active failure for *wrong time errors* was categorised by the researcher as rule-based mistakes. This means that the WTEs were considered to have been actions that were based on decision-making failures or errors of judgement by the nurses. For example, the researcher noted:

> "*The nurse obtained the tablet from patient's locker and gave it to the patient. This is because the patient regularly takes this medication every day and the supply stored in their locker. I detected that the nurse gave it at 10:03 am instead of 8:00 am. I think this error happens because of the extreme task demands e.g. high workloads where most patients were polypharmacy." RN*

Based on the observations made, the researcher related the error-producing conditions for this type of clinical error to staff workload (e.g. high workloads where most patients were on multiple medications). In addition, the researcher thought again that the latent condition related to the safety culture and priorities.

Further, the nurse interviews revealed the same opinion as the researcher's about the reasons for wrong time errors as errors of rule-based mistake. During the interviews, most of the nurses described wrong time errors in the context of decisions-making failures due to staff workload (e.g. ward pressure), patient attitude or inexperienced nurses as examples of error-producing condition. For instance, one nurse interviewee noted:

> *"Because you're discussing things with patients when they come in and you're just giving them a bit of time. And obviously if you give all the 27 patients that bit extra time it takes longer." PWN1*

Another nurse added:

> *"It does happen, yes, it does happen, example if staff coming outside, they're not used to in the ward. If permanent staff is very rare, I haven't seen anybody doing medicine more than two hours. But then I see a few staff who outside and they're taking more than two hour, because they're not used to it and it will take time to find the medicine and go through, yeah." CWN2*

The nurse interviewees related staff workload, patient attitude and inexperience nurses to safety culture and priorities as the latent condition. For example, one nurse stated:

> *"That's about having the person who's in charge of the whole ward allocating those jobs appropriately, and actually, if the nurse is doing meds, then that nurse needs to be doing meds, not dealing with the lunch trolley, as an example." LN1*

The pharmacists showed a similar view as the researcher and the nurse opinions about the WTEs being rule-based mistakes. Most of the pharmacists stated that WTEs occurred because of decision-making failures, relating the conditions to staff workload, as error-producing condition. For example, one pharmacist interviewee noted:

> *"It's very difficult, if the nurse is trying her best to get round in two hours, it's very hard to call it an error, so it's a type of error, so if they're trying their best and they just simply can't do it in two hours, but maybe their ward manager needs to put two nurses on doing the medication, so that it is possible for them to do it within two hours. Distractions and just a lot of medication, a lot of stuff when it's once daily is usually just put in the morning because that's just the convention and that makes the morning rounds very, very busy and people are getting up, they need to get washed, they need their breakfast, so there's just a lot going on for that also to be the biggest round in the morning." PH2*

Also, the pharmacists related the error-producing condition to the safety culture and priorities. One pharmacist explained:

> *"It's more for the ward manager that should organise their staff to make sure that they complete the ward round within whatever, two hours (inaudible) If he's more, something went wrong, we need to rearrange the staff because if he's, I don't think nurses are lazy it's just that they are busy and they cannot finish." PH1*

(Figure 4.8)

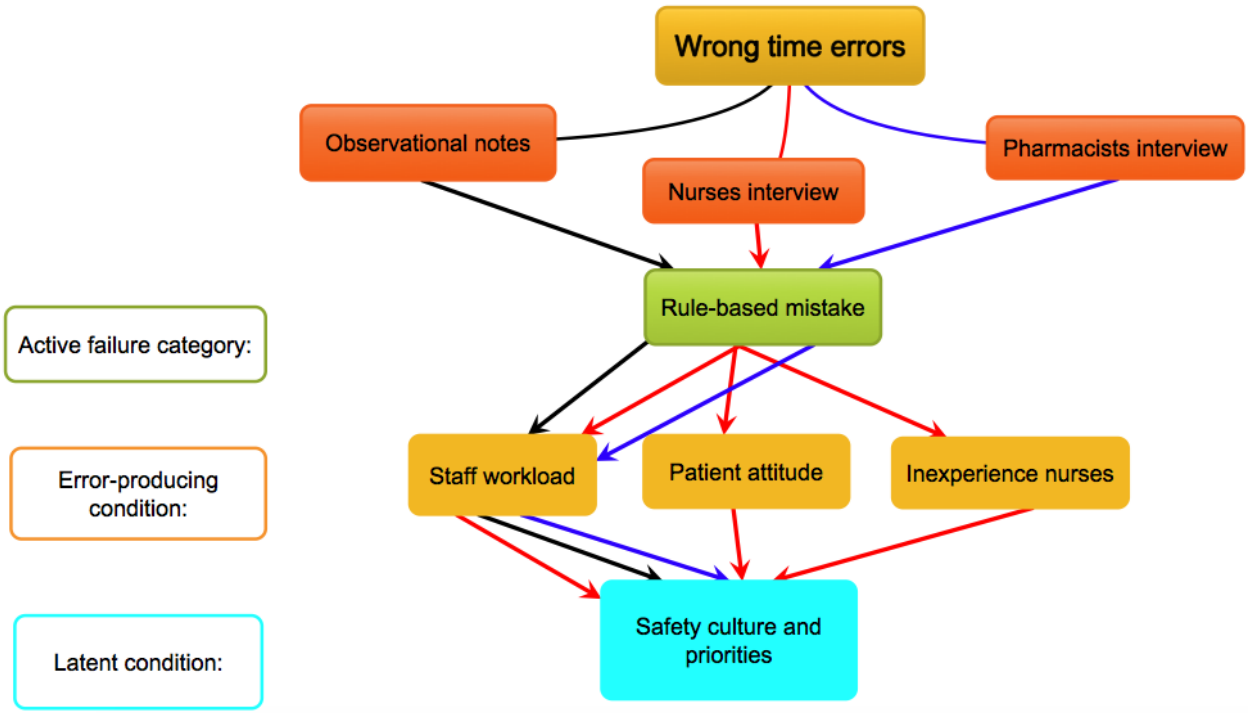

Figure 4.8: Consolidation of observational notes, nurses and pharmacists' interviews for the reason of wrong time errors

4.3.2.5 Reason for wrong dose errors

The active failure for *wrong dose errors* was categorised by the researcher as slips or situational violations. This means that the wrong dose errors were thought to have been based on the wrong physical actions or non-compliance with the rules. For slip example, the researcher noted:

> *"The nurse obtained the tablet from the locked trolley and gave it to the patient. This is because the patient regularly takes this medication as inpatient. I noticed that the nurse was attempting to give 1 gm instead of 750 mg then I intervene and remind to give the right dose. I think this happen because of the time pressure." RN*

The slips happen because the nurse selects the right item but the wrong dose. In another example for the situational violation, the researcher noted:

> "*The nurse obtained the ampoule from the trolley and gave it to the patient. This is because the patient regularly takes this medication as inpatient. I noticed that the nurse was attempting to give 0.3 ml instead of 0.2 ml then I intervene and remind to give the right dose. I think this happens because of the extreme task demands." RN*

When the researcher asked the nurse about taking 0.3 *ml* instead of 0.2 *ml* and whether she knows the right dose or not, the nurse said "*It is a busy ward and I took all the ampule but I know the right dose."* Based on the researcher observations, the related error-producing conditions for this type of clinical error were judged mainly to be related to staff workload (e.g. ward pressure or extreme task demands). In addition, the researcher expected that the latent condition related to the safety culture and priorities.

Moreover, the nurse interviews revealed a different view to the researcher about the reasons for wrong dose errors; they judged these as being knowledge-based mistakes and situational violations. One of the nurses also added omission as an active failure category. During the interviews, most of the nurses described wrong dose errors in the context of nurses not being careful, or not knowing how to calculate and they related these to different error-producing conditions such as of staff workload (e.g. ward pressure), lack of knowledge, miscommunication (drug chart order not clear) and inexperienced nurses. For example, one nurse interviewee noted:

> *"Well as I say from if they don't know how to calculate their, the liquid. But especially the tinzaparin do you know, if they don't know how, like 4,500 and 3,500 they come in different colours as well isn't it." CWN3*

Another nurse added that:

> *"Yeah, definitely. I think again I think sometimes nurses, particularly nurses that have been working a long time, rather than really taking in instructions, perhaps glance over. Think, oh I know what this says. Fill in the gaps kind of thing. I think it's always best for us not to assume that you know and to read what's directed properly." PWN1*

The nurse interviewees related these conditions to the safety culture and priorities (latent conditions). One nurse stated:

> *"Two staff that double check, having two staff to double check. Because some of the injections are preloaded." PWN2*

Another nurse said:

> *"Study days, and training and general discount of things. Double check always, yeah, always. If you're not sure ask your second opinion." CWN2*

In addition, the pharmacists' interviews revealed a similar view with the nurses about the reasons for wrong dose errors as being knowledge-based mistakes and situational violations e.g. most of the pharmacists stated that wrong dose errors occurred because of nurses not being careful or not knowing how to calculate and these were related to lack of knowledge and staff workload as error-producing conditions. One pharmacist added that sometimes proper equipment was not available.. For example, one pharmacist interviewee noted:

> *"Extremely poor training of the nurse that should know how to measure the right amount. They should be able to otherwise how can they be a registered nurse?" PH1*

Another pharmacist said:

> *"Why is it, because I think the nurse may not be familiar with maths, her mathematics may not be good. So, and they may, again, could be possibly distracted." PH3*

Also, most pharmacists related the error-producing condition to the safety culture and priorities (latent condition). For instance, one pharmacist explained:

> *"Practise I suppose and double checking each other if they're in any doubt. If they're feeling uncomfortable or doubtful, they should go and get checked, get a second check." PH2*

(Figure 4.9)

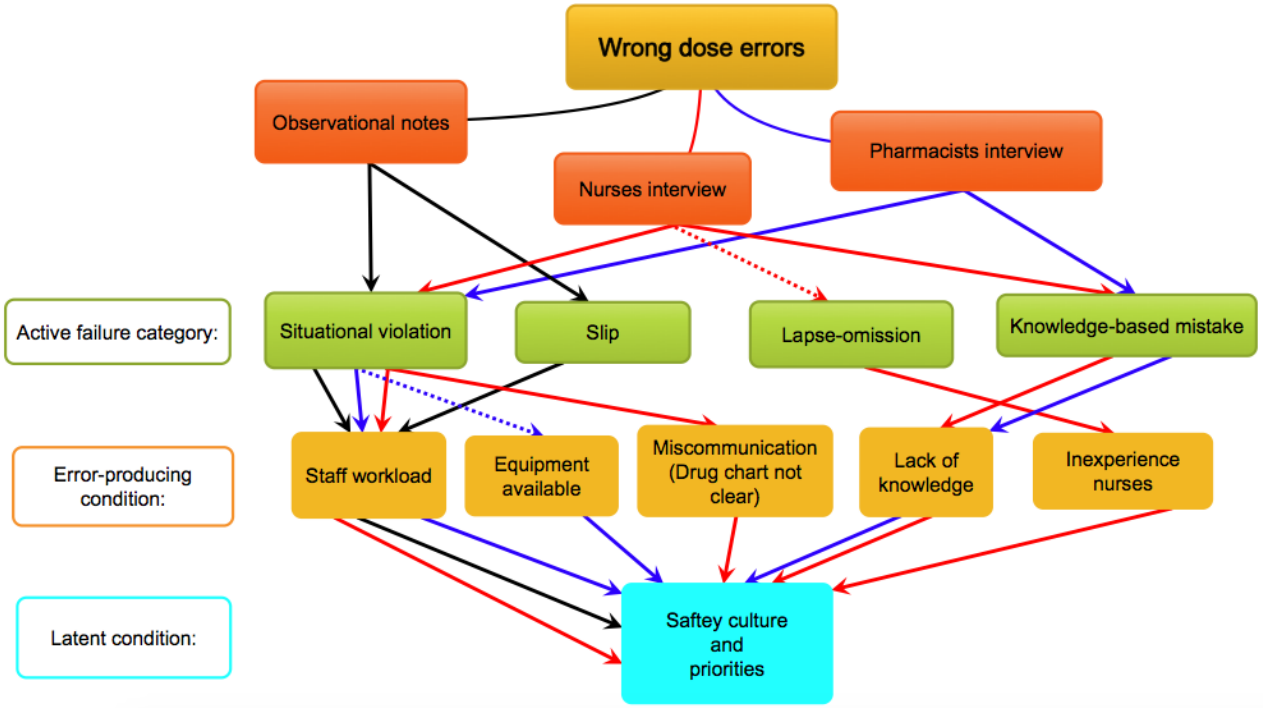

Figure 4.9: Consolidation of observational notes, nurses and pharmacists' interviews for the reason of wrong dose errors

Overall, Table 4.5 below illustrates the main active failure categories from the different perspectives, for procedural errors and Table 4.6 shows the main active failure categories for clinical errors from the overall observational notes and nurses' and pharmacists' interviews. Table 4.7 shows the summary of MAE causes from the observational notes that illustrate the numbers of active failure, error-producing condition and latent condition for each detected error.

Table 4.5: Active failures compared through the analysis – procedural errors

	Expiry errors	**Given but unsigned**	**Other errors**
Researcher	• Situational violations	• Lapse (omissions)	• Situational violations
Nurses	• Lapse (omissions) • Knowledge-based mistakes	• Lapse (omissions)	• Situational violations • Knowledge-based mistakes • Lapse (omissions) • Rule-based mistakes
Pharmacists	• Knowledge-based mistakes • Lapse (omissions) • Situational violations	• Lapse (omissions) • Situational violations	• Knowledge-based mistakes • Lapse (omissions)

Table 4.6: Active failures compared through the analysis – clinical errors

	Omitted and unsigned	Omitted but signed	Almost not given	Wrong time error	Wrong dose error
Researcher	• Lapse (omissions)	• Lapse (omissions) • Situational violations	• Lapse (omissions)	• Rule-based mistakes	• Situational violations • Slips
Nurses	• Lapse (omissions) • Situational violations	• Lapse (omissions) • Situational violations	• Lapse (omissions)	• Rule-based mistakes	• Situational violations • Knowledge-based mistakes • Lapse (omissions)
Pharmacists	• Lapse (omissions) • Situational violations • Rule-based mistakes	• Exceptional violations • Situational violations • Routine violations • Slip • Knowledge-based mistakes	• Lapse (omissions) • Knowledge-based mistakes	• Rule-based mistakes	• Situational violations • Knowledge-based mistakes

Table 4.7: Summary of MAEs causes from the observational notes

	MAEs	**Active failure**							**Error-producing condition**						**Latent condition**
		Slip	Lapse	Knowledge-based mistake	Rule-based mistakes	Routine violations	Situational violations	Exceptional violations	Staff workload	Miscommunication	Patient attitude	Inexperience nurse	Lack of knowledge	Nurse attitude	Safety culture and priorities
Procedural errors	Expiry Error						118		118						118
	Given but unsigned		18						18						18
	Other reason						57		57						57
Clinical errors	Omitted and unsigned		49						41	8					49
	Omitted but signed		5				14		14	5					19
	Almost not given		19						16	3					19
	Wrong time error				47				34			13			47
	Wrong dose	19					5		22			2			24
	Un-prescribed drug	2					1		2	1					3
	Extra Dose					3			3						3
	Formulation Error	6					4		5	4		1			10

From the researcher observation note, nurses and pharmacists' perspectives; there is no difference in active failures relating to the MAEs found between the psychiatric and community hospital wards as well as in the latent conditions. The researcher found that the situational violation was the same active failure of the expiry errors in both PWs and CHWs. Moreover, some nurses and pharmacists revealed that lapses were the same active failure for the expiry errors from both PWs and CHWs. One psychiatric ward nurse stated:

> *"We just forget. We just get the medications and open it to dispense it. I don't know. I think, yeah, just generally you just go to the cupboard, you open it up, you dispense. Yeah, I suppose you just, some people just forget."PWN2*

Another community hospital ward nurse said:

> *"Maybe they forget, maybe it's the rush, like pressure or something." CWN2*

In addition, some contributing factors were found more in the psychiatric wards such as written miscommunication (drug chart not clear) and patient factors. Whereas the verbal miscommunication (between the nurse the carers) were found more in the community hospital wards. For example, for omitted and unsigned one of PWs nurse illustrated that:

> *"Sometimes I think the drug cards are too many crossing outs from the doctors, where they've crossed out medications. So I think that's easy sometimes to miss, to miss the medication." PWN2*

Other CWs nurse explained:

> *"The E45 and the Cetraben creams are keeping with the patients. Ideally we are not the one who are doing that medications because that is prescribed but the carer is or the patients themselves, they are doing it. Yeah so that's the reason it happens. You wait for them to use it and then sign it." CWN1*

Furthermore, from the observation note the researcher found that most of the WTEs were linked to three CHWs used bedside-patient locker as a mode of administration and morning observation rounds. Similar notes were written each visit detected WTEs. For example, CHW1:

> *"This ward is used bedside locker, the administration round start at 8:00 am and finish at 10:25 am (more than 2 hours). There are many medications given after 2 hours." RN*

CHW2:

> *"This ward is used bedside locker, the administration round start at 8:00 am and finish at 10:15 am (more than 2 hours). There are many medications given after 2 hours." RN*

CHW9:

> *"This ward is used bedside locker, the administration round start at 8:00 am and finish at 10:25 am (more than 2 hours). There are many medications given after 2 hours." RN*

Also, from the observation note the researcher found that older adult patient in psychiatric wards used many non-psychotropic medications beside their psychotropic medication. For example, the researcher noted in one visit of the psychiatric ward used bedside-prepared in clinic room mode of administration PW8:

> *"The nurse under pressure, many medications was administered and most of it was non-psychiatric medications. Most of the patient need to be persuaded to take their medications and the nurse find difficult to give the patients their medications." RN*

The above findings showed the causes of MAEs from the researcher's notes perspective, the nurses and pharmacists views. The next section is about the MAEs from nurse and pharmacist opinions by answering other interviews questions as follows:

1- If they agree in principle that specific type of error should be coded as a medication administration error?
2- If they come across similar examples of this error in the past? or if this error could happen?
3- What would be the impact on the patient from the MAEs?
4- What would help to reduce the occurrence of this type of medication administration error?

Regarding question one, whether the participants agreed with the specific type of action being classed as an error; most of the nurses and pharmacists agreed about most of the situations (such as omitted and unsigned, omitted but signed, almost not given, given and unsigned, expiry errors, other reason errors, WTEs, and wrong dose) that it is an MAEs. For example, one nurse interviewee stated that:

> *"Yeah I do, because obviously if it's not signed off on the drug chart it's not given because you don't have the proof that you've given it unless you sign it." CWN3*

In another example, one pharmacist interviewee said:

> *"Yes, I think so. It's a medication administration error because they didn't check the, we cannot know if we give something expired, yeah." PH1*

Whereas a few of nurses disagreed whether in some of the situations (such as almost not given and other reason errors) where occurred is an MAEs. Also, a few pharmacists disagreed about whether some of the situations (such as omitted but signed, almost not given, and other reason errors) were MAEs. For instance, during the interview, the researcher asked whether they agreed in principle that did not rinse the patient mouth after giving the corticosteroid inhaler should be coded as medication administration error? One nurse noted:

> *"It is not medication administration error." CWN1*

Another example, one of the pharmacists said:

> *"I don't think it's a medication error on a nurse's part, I don't think. It's more like, because someone would have counselled the patient, they could have counselled them, you need to rinse." PH3*

On the other hand, regarding the question of whether these types of errors could happen in practice, most of the nurse and pharmacist interviewees agreed, however, some of the participants disagreed e.g. about the omitted but signed error, one of the nurses noted that:

> *"I don't think that happens. They sign without giving the medication?" PWN3*

In another example discussing the wrong time error one of the pharmacist stated that:

> *"No, it shouldn't, no. So, they should be able to do it in two hours." PH1*

Moreover, most of the nurse and pharmacist participants agreed that most of MAEs could have a negative impact on the patient. For instance, the impact of "giving the medication but unsigned" one nurse stated:

> *"They could potentially receive their medication twice, which could be terrible. Yeah, hopefully nothing, hopefully the person will go, oh, I need to sign that. But potentially they could receive that twice, and that's not good." PWN1*

Another example, one pharmacist noted:

> *"The risk to the patient is they get it again. That someone else comes along and gives it again or the nurse then gives it again and then they can't remember they've given it and they give it again anyway. Or they, yeah, they've had the medicine, the risk is of getting it again." PH4*

Finally, the nurse and pharmacist participants were asked about how to reduce the different type of MAEs via 'remedial interventions'? Some of the nurses had common suggestions (for example less interruption/distraction, self-double-check, two staff double-check each other's, training and education about errors), to reduce the omitted and unsigned errors, one of the nurses stated that:

> *"Yeah just check daily to make sure, a second person, they check on the drug chart." CWN2*

Most of the pharmacists had similar suggestions and added for example about the need for better planning for nurse staff, more staff organised, and raising the error profile to reduce the other reason errors, and one of the pharmacists noted that:

> *"I suppose pharmacy raising the profile again. We do meds management courses and I think that a lot of these, so all the nurses have to go on the meds management course and I think that raising these issues as part of the course will raise its profile." PH2*

4.4 Summary

In this chapter, the collected data were arranged and categorised deductively based on a framework of organisational accident causation, and the findings were compared between the observation notes and interviews, including the procedural errors were expiry errors, given but unsigned and other reason errors; the clinical errors were omitted and unsigned, omitted but signed, almost not given, wrong time error and wrong dose. The categories assigned to the errors were the active failure category in the first stage followed by the error-producing conditions and the latent conditions. Table 4.8 shows the overall findings quantitative and qualitative causation of MAEs using the "mixed methods matrix" (O'Cathain et al., 2010).

In summary the main active failure category for clinical errors was understood to be ‘lapses’, the main error-producing condition ‘staff workload’ and the main latent condition ‘safety culture and priorities’. For omissions there appeared to be a range of contributing reasons including workload, miscommunication and staff-related factors. The main active failure category for procedural errors was judged to be ‘situational violations’ by the researcher, especially in relation to expiry errors and other reasons (e.g. adhering to counselling instructions) but this was not the view of nurses and pharmacists who painted a more blameless picture of the workplace. Overall, the analysis of these qualitative data as well as the quantitative data will be discussed in relation to the research objectives in the next chapter.

Table 4.8: The overall findings quantitative and qualitative causation of MAEs

Category	**Type of error**	**Cause of MAEs**						
		Researcher notes		Nurses interview		Pharmacists interview		PRM
		Active failure	Error-producing condition	Active failure	Error-producing condition	Active failure	Error-producing condition	
Procedural errors	Expiry error	Situational violations	Staff workload	Lapse, Knowledge-based mistakes	Staff workload, Lack of knowledge	Knowledge-based mistakes, Lapse, Situational violations	Staff workload, Lack of knowledge	**PRM for procedural errors found** -Bedside-prepared in clinic room and bedside-patient locker are increased risk by 136% and 54% -Non-psychiatric drugs resulting in an increased risk of 2.3 times the psychiatric drugs
	Given but unsigned	Lapse	Staff workload	Lapse	Staff workload, Patient attitude	Lapse, Situational violations	Staff workload	
	Other reason	Situational violations	Staff workload	Situational violations, Knowledge-based mistakes, Lapse, Rule-based mistakes	Staff workload, Patient attitude, Lack of knowledge	Knowledge-based mistakes, Lapse	Staff workload, Lack of knowledge	
Clinical errors	Omitted and unsigned	Lapse	Staff workload, Miscommunication	Lapse, Situational violations	Staff workload, Miscommunication	Lapse, Situational violations, Rule-based mistakes	Staff workload, Patient attitude	**PRM for clinical errors found** -08:00 and 12:00 significantly increased risk of clinical errors by 2.5 and 2.4 times - Bedside-patient locker and mixed mode of administrations are significantly increased risk of 2.4 and 2.7 times -Band 6 and agency nurses staff are significantly different from band 5 nurses staff with a lower risk of 47% and 43% respectively
	Omitted but signed	Lapse, Situational violations	Staff workload, Miscommunication	Lapse, Situational violations	Staff workload, Miscommunication, Patient attitude, Inexperience nurse	Exceptional violations, Situational violations, Routine violations, Slip, Knowledge-based mistakes	Staff workload, Miscommunication, Nurse attitude, Inexperience nurse, Lack of knowledge	
	Almost not given	Lapse	Staff workload, Miscommunication	Lapse	Staff workload, Patient attitude	Lapse, Knowledge-based mistakes	Staff workload, Lack of knowledge	
	Wrong time error	Rule-based mistakes	Staff workload	Rule-based mistakes	Staff workload, Patient attitude, Inexperience nurse	Rule-based mistakes	Staff workload	
	Wrong dose	Situational violations, Slips	Staff workload, Inexperience nurse	Situational violations, Knowledge-based mistakes, Lapse	Staff workload, Miscommunication	Situational violations, Knowledge-based mistakes	Staff workload, Lack of knowledge	

* Researcher, nurses and pharmacists related these conditions to the safety culture and priorities as latent conditions

Chapter 5 Discussion

This chapter discusses the findings of this study with regard to the work of other published scholars about MAEs. In this study, a mixed-method approach was adopted to combine the data from different sources.

Firstly, the quantitative data of this research presents the results of ward observations, including verifiable relationships between the number of errors found and a number of potential contributing factors which increase the risk of procedural errors and clinical errors.

Secondly, qualitative data analysis was also undertaken in order to provide supportive evidence about the cause of MAEs; through the researcher's observation notes, nurse and pharmacist interviews on experiences of medication administration errors, and these findings offered an understanding of opinions and perceptions about causes of MAEs and contributory factors within the Trust wards. This chapter presents a comparison and triangulation of both the quantitative and qualitative data.

5.1 Quantitative data

There are no previous studies observing MAEs in community hospital wards as well as psychiatric wards and studies of psychiatric wards are limited. A large direct observational study by Cottney and Innes (2015), investigated medication administration errors on mental-health wards arguing that these warrant separate investigation because the mode of administration on these wards is different to common practice in general wards. For example, patients in mental-health settings can attend a central location to receive their medication rather than receiving their medication at their bedside.

In this current study, 19 wards were observed (9 community hospital wards and 10 psychiatric wards) during different medication administration rounds and this is the first study that combines psychiatric wards and community hospital wards. Moreover, this research study is particularly novel because it has investigated different modes of administration using the same researcher and methodology; i.e. medicines administered from clinic room that includes the queuing mode, bedside-prepared in clinic room or mixed administration mode on psychiatric wards, and medicines administered from drug trolley or from patient locker in community hospital wards.

Overall, the quantitative findings showed a total error incidence rate of 16.4%. The MAEs rate reduced to 14% after excluding WTEs as some other studies have (Bruce and Wong, 2001, Chua et al., 2010). The MAEs rate in this current study was above the average error rate in the UK from studies that have observed non-IV medications using paper drug charts, which have shown the rate to range from 3%-8% (Dean et al., 1995, Ho et al., 1997, Taxis et al., 1999, Cottney and Innes, 2015). Only one previous study has shown a higher error rate of 25.9% which took place on psychiatric wards (Haw et al., 2007). On the other hand, when the errors were separated according to procedural errors and clinical errors; the clinical error rate in the current study was 7.7% which is within the error rate range noted in other studies (Dean et al., 1995, Ho et al., 1997, Taxis et al., 1999, Cottney and Innes, 2015).

In addition, when the error rate was divided according to ward type; the CHWs error rate was 17.4% and PWs error rate was 15.2% where both rates were still above the error range noted in other studies (Dean et al., 1995, Ho et al., 1997, Taxis et al., 1999, Cottney and Innes, 2015) and within the error rate range (8.6-28.3%) noted in a systematic review study (Keers et al., 2013b). Also, MAEs rate of PWs in current study

was still within the range (3.3-48%) that was stated in a mental-health systematic review study by Alshehri et al. (2017).

Furthermore, comparing the errors detected showed that expiry error was the most frequent type of MAEs followed by omissions. Other studies reported in the literature review stated omissions as the most frequent type of MAEs (Dean et al., 1995, Ho et al., 1997, Taxis et al., 1999, Cottney and Innes, 2015). This difference in what constitutes the most frequent type of medication administration error as found in this research compared to the literature could be due to the study setting which combined psychiatric wards and community hospital wards, whereas previous studies have focused on *either* psychiatric wards or general hospital wards. However, another explanation for the high rate of expiry errors found could be due to the definition and procedure for classifying this type of error as described below.

In this study, the definition of expiry errors was very broad and included the administration of the drug that did not have a label showing the opening and expiry date such as (liquid medication, eye drops and insulin). In the literature, however, there is no consistency in relation to what counts as an expiry error. Whereas the very strict definition would be "the administration of a drug that had deteriorated due to incorrect ward storage or had exceeded its expiry date" (Taxis et al., 1999), however, in this research, the broader definition used resulted in the findings noted above.

Furthermore, the results from the total of MAEs included the procedural and clinical errors where in most previous studies clinical errors were the only MAEs reported. If for the current study, clinical errors only are considered, omission was the most frequent type of error overall similar to previous studies (Dean et al., 1995, Ho et al., 1997, Taxis et al., 1999, Cottney and Innes, 2015). Correspondingly, by separating the

errors type between the CHWs and PWs, still the expiry errors were the most frequent type of MAEs followed by omissions. However, when considering the clinical errors only, omission was the most frequent type of error in CHWs and PWs followed by WTEs in CHWs and wrong dose in PWs, this was similar to error type finding in the study by Alshehri et al. (2017).

Another finding presented in the current study is that most of the errors detected were of little clinical importance. The potential harm from the errors detected were considered minor in both CHWs and PWs, which supports the finding of previous studies (Berdot et al., 2013, Cottney and Innes, 2015, Alshehri et al., 2017) which showed that most of the errors detected were of minor clinical importance. Cottney also divided the severity of error into four categories (Negligible, Minor, Serious and Fatal), however, in the current study the errors found were categorised to potential of harm, and no harm.

5.2 Contributing factors increase the risk of errors

As mentioned in Chapter 1, the purpose of the study was to identify the baseline rate of MAEs at BHFT and to determine the relationship between possible contributing factors and the error rate. The PRM was used to determine the combination of some variables (contributing factors) with regard to the occurrence of MAEs. The test revealed that, two contributing factors in relation with the risk of procedural errors and three contributing factors in relation with the risk of clinical errors.

Considering the impact of the administration mode on increasing the risk of errors; for example, in bedside-patient locker the findings showed that the procedural errors and clinical errors had a similar rate which is also considered a very high rate. The expiry errors and the wrong time errors were the highest type of error in this situation. On

closer examination, it becomes apparent that the three wards (CHW1, CHW2 and CHW9) which used bedside-patient locker were experiencing the highest number of expiry errors and wrong time errors. Comparing the findings with some previous studies mentioned in the literature review (Camac et al., 1996, Hogg et al., 2012), these had reported that the bedside-patient locker helped to *reduce* the error rate. Another study by Dean and barber (2000), found that there was no difference between the uses of bedside medicine cabinets vs. the traditional system, on the MAEs rate. However, the finding of this research study is different compared to the previous studies; that the bedside-patient lockers are one of the factors that could increase the risk of MAEs. Moreover, the finding that the nurses were taking too long to finish the round when using patient lockers mode of administration, is in direct contrast to the National Prescribing Centre (NPC, 2007, 2008) which suggested bedside-patient locker could help to make better use of nurses' time.

Other findings from the current study are that the expiry errors rate was very high in bedside-prepared in clinic room mode of administration when compared to the other modes. Bedside administration where the medication is prepared in clinic room is a common administration mode used in psychiatric wards that care for older adults' patients with dementia. Most of these expiry errors in this instance were related to non-psychiatric medications such as liquid bottles, eye-drop and insulin for older adults in these wards which were prepared in the clinic room but administered by the patients' bedside. According to Trust procedures, there are specific medications which should be labelled with a date they were opened to calculate the expiry date. The older adults' patients on these wards usually had a lot of non-psychiatric medications besides their psychiatric medications and that showed the bedside-prepared in clinic room could increase the risk of these procedural errors.

Moreover, the researcher believed from the point of view of an observer, in wards using 'bedside-prepared in clinic room' some nurses were occasionally under pressure and found it hard dealing with several older patients sequentially all in one round. Here there were patients with disabilities and evidence of cognitive decline, and providing them their medications, taking into account that some of the patients had a high number of medications, potentially resulted in nurses making a conscious decision to not comply with the rules about checking the opening and expiry date or rules about writing the date when a new package is opened. This meant that on reflection, the researcher categorised the expiry errors occurred due to nurses' staff workload and this contributing to 'situational violation'. However, the nurses had a different point of view that usually expiry errors happened which to them was because 'some' nurses' lack of knowledge or forgetting due to work pressure. In this way, the health professionals interviewed painted a more innocent picture of the workplace where mistakes occurred not consciously but unintentionally.

Another point is that the omissions rate was higher in 'mixed bedside-prepared in clinic room and queue mode of administration' compared with the omission rate in other modes. The 'mixed bedside and queue' mode is one of the administration modes used in psychiatric wards. Omissions could occur because different modes were being used at the same time, which left some nurses under pressure and (in the researcher's opinion) confused. Therefore, omissions were considered by the researcher to be mainly related to nurses' forgetting, akin to Reason's category of 'lapses' due to workload as a contributory factor. This provides an explanation for why the 'mixed bedside and queue mode' could increase the risk of clinical errors. In addition, the researcher observations, and nurses' and pharmacists' points of views were similar, in that lapses are the most relevant reason for omissions and that this is due to workload.

Another finding was that non-psychiatric drugs increased the risk of procedural error. This could be because the requirement to add expiry dates relates to liquid bottles, eye drops and insulin which are mainly non-psychiatric, also most of 'other reasons' for MAEs found related to inhalers or tablets which were categories of medicines that were mainly non-psychiatric. For example, dispersible aspirin, where the tablets were not dissolved prior to administration, the orodispersible tablets of olanzapine (although this is a psychiatric drug) which patients were told to swallow directly (rather than dispersing in the mouth), and corticosteroid inhalers where patients were not directed to rinse their mouth straight after use. Usually, the dispersible and orodispersible tablets are clearly written in the drug chart, and rinsing mouth straight after use corticosteroid inhalers is written in green by the pharmacist that nurses needed to do this. This meant that on reflection, the researcher categorised the 'other reasons' for MAEs occurred due to nurses wilfully choosing not to do something due to staff workload, which is contributing to situational violation. A study by Maidment et al. (2008) stated that non-psychiatric medication in older adult mental-health sittings are considered as one potential risk factor linked to errors.

In addition, from the analysis of the results, 08:00 is one of the factors that could increase the risk of clinical errors. It was found that some drug administration rounds took a long time to complete in the morning rounds which resulted in a higher occurrence of wrong time errors. This administration time was the only time where WTEs occurred frequently. This is explained by the fact that the morning rounds are busier than other rounds due to the higher number of medicines being prescribed to be given in the morning. An indication of the busy nature of wards in the morning rounds is gleaned by considering that the average OE for 08:00 round was 50 compared to just 17 for 12:00 rounds. A study by Rodriguez-Gonzalez (2011), showed that most

medications are administered at morning time and the factors associated with a higher risk of administration errors was in the morning shift due to poor communication between the physician and the nurse in the morning shift when more treatment modification were made.

This was also noticed by the researcher during the observation at 08:00 round time, where most of the patients' medications were given at this time on most wards. Some patients have a high number of medications, beside it is their breakfast time and other activities are taking place which makes it very busy for the nurses. This means that administration at morning round time could sometimes take longer than at other round times, where WTEs could occur by some nurses based on decision-making failures or errors of judgement (rule-based mistakes). To explain, if a medication round is taking longer than 2 hours to complete, then nurses might need to make a conscious decision to omit a patient's dose of medication from the morning round, if there is now a less than 2 hours gap between this round and the start of the next. For medicines such as paracetamol or diazepam the shorter gap between administration rounds (the current one and the next one) could cause serious problems. Moreover, the nurses and pharmacists appeared to hold a similar view to the researcher in terms of the reasons for WTEs as being rule-based mistakes due to staff workload.

Another finding was that the nurses unintentionally omitted the medications more at the lunch round time 12:00 when compared to the nurses' omission in other rounds time, which explained how the 12:00 increase the risk in clinical errors. The researcher detected during the ward observations that at 12:00, some nurses were under pressure (workload), and usually this time was busier with other activities taking place especially

lunch time breaks, and this led to some nurses (lapse) forgetting to give medications to patients which was the main reason for omissions.

The finding that band 5 nurse grade was a factor that increased the risk of clinical errors which could be because band 5 nurses had more chance of committing clinical error than band 6 (by virtue of being in charge of more rounds) or it could be because band 6 nurses were more cautious during administration rounds as this is not a part of their everyday role. There is no specific reason for band 5 nurses to have committed more errors, however, from the researcher's viewpoint, this could be related to the fact that band 5 nurses had the most responsibilities of drug administration round in BHFT while they were also under pressure and busy with double tasks at the same time during administration rounds (e.g. 42 band 5 nurse grade administrations were observed from a total of 65 nurse observations).

Overall, it was found that the contributing factors in the current study were different from a previous study set in a mental health Trust reported in the literature by Cottney and Innes (2015). That study used similar methods to PRM and identified the contributing factors and focused on psychiatric wards only. The study found that the risk of error was increased with the nurses interrupting the medication round to attend another activity, an increased number of 'when required' doses of medication administered, a higher number of patients on the ward, and an increased number of doses of medication due (Cottney and Innes, 2015). The next section discusses the reason behind the presence of errors from the researcher's, nurses' and pharmacists' perspectives.

5.3 Qualitative data

The purpose of this section is to discuss the main findings and the characteristics of the qualitative data collection including the researcher's observation notes, and nurses' and pharmacists' interviews of experiences of MAEs to provide supportive evidence about the cause of MAEs in relation to the research objectives. These findings offered an understanding of interviewees' opinions and perceptions about MAEs within the Trust wards. A study by Keers et al. (2013a), stated that direct observation combined with interviews, could bridge the gap between causes of errors that could not be identified by the observer, or when nurses could not notice the causes of errors themselves. Also, direct observation could identify potential causes of MAEs and related factors, as well as providing these data did not depend on researcher's opinion on causation (Keers et al., 2013a).

During this study, the researcher observed all wards and made notes on each potential error. Then these findings were compared with data from semi-structured interviews, with a sample of eight nurses and four pharmacists. The aim of these observation and interviews was to compare and contrast the main causes behind the procedural and clinical errors by categorising them to three levels (active failures, error-producing condition and latent condition) by adopting the adapted organisational accident causation model.

5.3.1 Categorising the active failure category

To start with, the findings relating to the active failures revealed that there were some similarities and differences between the researcher observation's notes compared with the staff interviews. On the other hand, there were no differences in terms of the active failures found in PWs and CHWs. First, the observation findings indicated that the

highest active failure in clinical errors was in lapses which were detected as omission errors. This was similar in a previous study (Keers et al., 2013a), which used Reason's accident causation model to provide the causes of MAEs, as being slips and lapses in terms of the most significant unsafe acts (active failures). Similarly a qualitative study by Keers et al. (2015) that investigated the causes of IV MAEs in general hospital wards showed that slips and lapses were the more frequently detected active failure than mistakes and violations. On the other hand, another qualitative study by Keers et al. (2016) focused on the cause of MAEs in the mental-health hospital setting found that the active failure is divided between errors and violations. Additionally, most of the nurse and pharmacist interviewees in the current study were in agreement with the researcher about the cause of omission errors being lapses. Therefore, it seems that where omissions take place, there is general consensus about these being 'action errors' namely memory-based action-not-as-planned.

Second, the second-highest active failure type in clinical errors was in wrong time errors categorised by the researcher to be rule-based mistakes. From the observations, it was found that most of the nurses were insisting to complete the administration even if the 2 hour window for completing the round had passed. The rule-based mistake here is a type of thinking error, 'action-as-planned'. The researcher, nurses and pharmacists were in agreement about the cause of WTE. In all, these findings showed that the nurses' and pharmacists' perspectives and that of the researcher were very similar in terms of the causes of WTEs as a type of clinical error, akin to the omissions described above. However, there were some slight differences between the researcher's, nurses' and pharmacists' opinions in causes of the active failure type for wrong dose errors one of clinical errors type. The researcher believed that wrong dose errors might occur due to situational violations as the active failure where some nurses do not comply with the

rules during the administration or due to slips where some nurses administered the right drug name but at the wrong dose. Some nurse and pharmacist interviewees had similar views to the researcher that wrong dose might be due to situational violations. However, some others believed that knowledge-based mistakes were the active failure category relating to wrong dose errors where some nurses had lack of knowledge which is also found by Keers et al. (2015).

In relation to procedural errors, from the researcher's viewpoint 'situational violation' was the highest active failure category in relation to these, followed by 'lapses'. Most of the expiry errors and other reason errors found if not all, were due to the nurses not complying with the rules. In 'given but unsigned' nurses sometimes forgot to follow the rules.

However, there appeared not to be much agreement in terms of the nurses' and pharmacists' perceptions and that of the researcher's in terms of the active failures taking place in relation to procedural errors. There were some similarities too and these will also be explained. For example, 'given but unsigned' is a procedural error and the researcher, the nurses and the pharmacists interviewed seemed to concur that these were a result of lapses, i.e. 'action-not-as-planned'. In contrast, there appeared to be discord between the researcher's view about the cause of expiry errors and other reason errors, and the viewpoint of nurses and pharmacists. Here the researcher categorised expiry errors and other reason errors as situational violations, a type of deliberate non-compliance whereas the nurses and pharmacists conceptualised these as unintentional mistakes.

Overall, the reason for these differences might be due to nurses in interviews not wanting to admit their errors, or not feeling comfortable to respond to the questions

especially those related to potential violations. A systematic review study by Tully et al. (2009), concluded that interviews could bias and interviewees be affected by social appeal, where they might respond to questions in a way that makes the answers socially acceptable e.g. when asked about potential violations, it could be that nurses and pharmacists did not want to refer to actual intentional violations.

5.3.2 The error-producing conditions

The error-producing condition is the contributing factor that could lead to the active failures. Vincent et al. (1998), stated that error-producing condition in health care might be related to the patient itself, task, work environment, individual health care professional or team health care professional. From the researcher's observation, it was judged that the highest and main error-producing condition is 'staff workload' where the nurse administered to more patients and more doses of medication due to time pressure e.g. (08:00) and ward pressure (e.g. patient locker mode of administration), or where the nurse was interrupted and distracted which is also related to 'work environment' factor. Moreover, some other error-producing conditions were found such as 'written miscommunication' (prescription not clear in psychiatric wards) that is related to team factor and 'inexperienced nurses' is related to individual healthcare staff factor. According to the researcher's opinion staff workload was the main error-producing condition for slips, lapses, rule-based mistakes, and violations. Workload was also supported in previous studies used direct observation for example, a study by Taxis and Barber (2003b), found that an increased error rate could be due nurses' workload (perform numerous tasks at the same time, working past the end of their shift, or nurses being a lack of qualified staff). A further study by Tissot et al. (2003), revealed that workload increased errors due to increased number of patients per nurse.

Cottney and Innes (2015), found that high workload could have negative effect on nurses safely administering medications.

Furthermore, some of the nurse and pharmacist interviewees considered that the main error-producing condition for lapses, situational violation and rule-based mistakes was 'staff workload' that is related to 'work environment'. One of the nurse interviewees indicated that some nurses might forget due to distraction and rushing time (*PWN1*). Some other error-producing conditions were argued by nurses such as, 'verbal communication' miscommunication between nurses and carers in community hospital wards and 'written communication' miscommunication (drug chart order not clear) in psychiatric wards where some doctors crossed out medications many times which makes it difficult for the nurse to read, and both are related to team factor.

Another error-producing condition was 'patient attitude' e.g. the nature of patients in psychiatric wards as well as elderly patient in community and psychiatric wards is related to patient factor. Also 'inexperienced nurses' was where some nurses were deemed not to be familiar with wards and patients such as bank and agency nurses which is also related to individual staff factors. The pharmacists' interviewees had similar opinions for the error-producing condition as the nurses here.

The qualitative analysis revealed several meaningful findings that the main error-producing condition from all scenarios (researcher observation, nurses and pharmacists) was 'staff workload' and that the main contributing factor of lapses, situational violation and rule-based mistakes. Workload is also one of the error-producing conditions that contributed to slips and lapses as mentioned in the literature (Keers et al., 2013a). This is similar to general hospital wards study by Keers et al. (2015) which revealed that workload that related to distractions from patients generally contributed to

slips and lapses, and high workload such as busy and noisy environment which lead to rushed and distracted nurses also contributed to violations and mistakes. Additionally, Keers et al. (2016) found that in the mental-health ward workload (busy and noisy working environment that lead to interrupted and distracted the nurse staff) was the main error-producing conditions. Overall, these results have drawn the attention to the fact that 'staff workload' could be also related to the administration mode or the administration round time.

In addition, the researcher observation and nurses both pointed to the 'written miscommunication' (prescription not clear) being one of the error-producing conditions in mental-health wards. This is also found in general and mental-health wards studies (Keers et al., 2015, Keers et al., 2016), however, Keers et al. (2015) describes this type of error-producing condition as healthcare team factor where prescribers are using incorrect sections of the prescription chart and nurses stated poor relationships with staff which prevented them from clarifying unclear or possibly incorrect prescriptions. Beside that 'inexperienced nurses' is another error-producing condition indicated from the researcher observation, and speaking with nurses and pharmacists, where some of the nurses (e.g. agency) were not familiar with the ward and this was also found in the study by Keers et al. (2016). Some other error-producing conditions found (Keers et al., 2015) were related to equipment and the drug administration task which was not found in the current research study. These differences and similarities of error-producing condition findings in the current study settings and other studies could help to configure the key elements for an effective intervention to reduce MAEs in the future.

5.3.3 The latent conditions

The latent condition is the cause that could lead to error-producing conditions within which an active failure occurs, so these are either organisational and management factors or institutional context factors (Vincent et al., 1998). In this study, the researcher's point of view was that 'safety culture and priorities' was the main latent condition behind MAEs which is related to organisational and management factors. Safety culture and priorities in the organisation should enhance nurses' knowledge and beliefs regarding medication administration safety and address the work priorities. As an example, from the researcher's observation, some nurses need more training to enhance their skills dealing with workload such as, interruptions, ward pressures and time pressures and managing their other work priorities. Moreover, regarding work priority the organisation could help to allocate adequate staff level to support the volume of work.

The nurse and pharmacist interviewee had similar viewpoints as the researcher that safety culture and priorities might, if addressed, minimise the number of errors. For example, some of nurses and pharmacists suggested double-checking the drug chart before the wards round ends in order to make sure that every drug is given and signed, two nurses could double-check each other if there is any doubt, and giving nurses more training and making sure they are not distracted during the administration.

Increasing nurses' skills and knowledge during medication administration rounds is the organisations' responsibility and forms part of efforts to enhance the safety culture, for instance through nurse training on double-checking and more training on types of errors and how to remember these types of errors. All of these suggestions might lead to improvements in the medications safely and reduce the rate of MAEs. Keers et al.

(2013a), argued that safety culture consists of a combination of values, behaviours, and attitudes for individuals and groups, to increase the safety of the organisations, however, the nature and impact of this culture on MAEs is still unclear. On the other hand, Leonard & Frankel (2012), stated that when organisations make it safe for healthcare teams to discuss errors, so that a strong learning culture will be developed, and being consistent in their accountability for unacceptable behaviours that create risk, will have a strong impact on the safety culture as well.

The above discussions were in relation to the main results; the reasons for MAEs and contributory factors. There are other findings from the interview questions indicated the extent of knowledge about the errors for the interviewees, where most of the participants showed a good level of knowledge about the type of errors and this could help in future work to determine the right method to address these errors. Moreover, these perceptions could also help to develop recommendations for a training program. On the other hand, the question about how to reduce the type of errors help to extract more of the participants' opinions about the latent condition and that might help to draw the map of the intervention to reduce MAEs in recommendations section which will be explained in more detail in the next Chapter.

5.4 Summary

This chapter has discussed the main findings from the researcher observations quantitatively. In this current study, findings revealed that MAEs rate was above the average error rate in the UK studies. However, when number of errors separated to procedural errors and clinical errors; the clinical error was within the error rate average noted in other studies. Furthermore, the total number of errors detected, showed that expiry errors were the most frequent type of MAEs followed by omissions then 'errors

for other reasons'. Moreover, the PRM test revealed that, two contributing factors increase the risk of procedural errors and three contributing factors increase the risk of clinical errors.

The chapter also discussed the main interpretations from the researcher's observational notes, nurse and pharmacist interviews about experiences of MAEs (qualitatively); with the aim to reach a paper consensus about the main causes behind the procedural and clinical errors by categorising them to three levels, active failures, error-producing condition and latent condition. The active failures findings revealed that there were some similarity and differences from the researcher's observation opinion compared with the staff interviews. Moreover, the main error-producing condition from all scenarios (researcher observation, nurses and pharmacists) was 'staff workload' which is also the main cause of active failure for lapses, situational violations and rule-based mistakes. Finally, the latent condition is the cause that could lead to error-producing condition in which active failure occur, and these relate to either organisational and management factors or institutional context factors. 'Safety culture and priorities' was considered as the main latent condition behind MAEs from the researcher's, nurses' and pharmacists' point of views. The next chapter will consider the conclusions of this research study, significant research findings as well as its limitations, contribution to knowledge, research recommendations and any future work required.

Chapter 6 Conclusion

This research study examined firstly the MAEs rate and types, including omissions and blank boxes, on all wards at one UK Trust using the direct observation method. One of the objectives of the study was to record the apparent reason for omissions and blank boxes as well as any other MAEs observed to take place. Moreover, a selection of relevant healthcare staff was interviewed in order to gain a more in-depth understanding about the reasons behind the MAEs, and other deviations from practice guidelines including omissions and blank boxes etc. The ultimate objective of this thesis was to make evidence-based recommendations for improving medication administration practices at the Trust and in other similar settings. This mixed-method study makes a novel contribution to knowledge as the first study to compare mental-health and community hospital wards using the direct observation method, researching different modes of administration, and then comparing and contrasting the perceptions of the researcher with nurse and pharmacist opinions for causes of MAEs.

This thesis described a mixed-method study that examined in depth the rate and causes of MAEs within mental-health and community hospital wards. The medication administration methods were vastly different in that some used a standard trolley system, some a queuing method and some a patient locker system. This chapter draws conclusions from the study, and presents a summary of the research conducted.

Chapter 1 looked at the literature and provided a review of different modes of drug administration on wards; drug trolley, bedside locker and the clinic room. The literature review also covered an introduction to MAEs, definitions, and methods used to determine MAEs. There was also a review of some of the literature about the rate of

MAEs, type and frequency of MAEs, rate of harm, contributing factors linked to the risk of MAEs and suggested interventions to reduce the MAEs.

Chapter 2 described in details the overall research design and methodology used in this thesis. Also, the theoretical framework relating to medication errors, including human error theory, 'Swiss Cheese' model and the organisational accident model were outlined. The organisational accident causation model was adopted in this study. The chapter also considered the methodology relating to pharmacy practice, and different methods of data collection were presented. The methods of data were then clarified in terms of the nature of quantitative and qualitative approaches (observation and semi-structured interviews). It was argued that the mixed-methods offered a broader understanding of MAEs. Next, the data collection included sample size and recruitment, ethical issues, payment, data protection and confidentiality. The chapter concluded with the quantitative and qualitative data analysis.

In Chapter 3, the main quantitative findings of this thesis were analysed focused on presenting the entire data in relation to the ward observations. To provide an overview the data recorded on the MAE observation forms were quantitatively processed. Firstly, the descriptive data analysis looked at the total number and average of OEs, and the number of MAEs and the total and average error rates. This was followed by the inferential statistical data analysis using the PRM that examined statistically verifiable relationships between the number of errors found and a number of potential contributing factors.

Chapter 4 reported on the qualitative findings of this thesis, including the comparison between the observational notes and the semi-structured interviews which provided a more in-depth finding relating to medication administration practices, and gained the

healthcare professional (nurse and pharmacist) opinions about the reasons behind the MAEs, and the contributing factors. These were compared with data from observation notes. The MAEs were considered as procedural errors; expiry errors, given but unsigned and other reason errors, and clinical errors; omitted and unsigned, omitted but signed, almost not given, wrong time error and wrong dose. These MAEs were categorised as the active failure category in the first stage followed by error-producing condition and the latent condition.

Chapter 5 discussed the overall findings of the study and discussed the investigation corresponding to the work of other published scholars related to MAEs.

Overall, this chapter concludes with the significant research findings, limitations, contribution to knowledge, recommendations as well as providing suggestions for future research work.

6.1 Significant research findings

Two main objectives were considered to achieve the aim of this study:

1- To identify the baseline rate of medication administration errors at BHFT for psychiatric wards and community hospital wards by measuring quantitatively:
   a) The number and type of medication administration errors.
   b) A range of possible contributing factors including administration times, interruptions, staff shortages and medication administration practices.

2- To explore the healthcare professionals' perceptions qualitatively:
   a) Their experience of MAEs within the Trust wards.
   b) Their opinions about the reasons behind the MAEs, and the contributing factors to the different type of MAEs.

The main findings which presented in Chapters 3 and 4 are highlighted below, as well as the implications of these findings for clinical practice at the Trust.

The quantitative and qualitative findings were that:

1- The MAEs rate was higher than the average found in the literature, however, if procedural errors were excluded the error rate was within the range found in other studies.

2- The most frequent type of MAEs was expiry errors followed by omissions; however, if procedural errors were excluded omissions were the most frequent type.

3- The PRM test revealed contributing factors that might increase the risk of procedural errors as being bedside-prepared in clinic room and bedside-patient locker modes of administration and administration of a non-psychiatric drug.

4- The PRM test revealed contributing factors that could increase the risk of clinical errors as being 08:00 and 12:00 round times, bedside-patient locker and mixed mode of administrations and band 5 nurse grade.

5- The main active failure for clinical errors was that of lapses as indicated by the researcher, nurses and pharmacists.

6- The main active failure in procedural errors was situational violations from the researcher perspective which was not in agreement with the nurses' and pharmacists' perceptions.

7- The highest and main error-producing condition was judged to be 'staff workload' agreed by the researcher, nurses and pharmacists.

8- The main latent condition behind MAEs was 'safety culture and priorities' agreed by the researcher, nurses and pharmacists.

No previous study found in the literature review examined the topics in the current study by combining an examination of MAEs on psychiatric wards and community hospital wards. Also, this research is considered first of its kind to investigate different modes of administration, and comparing and contrasting of the researcher observation with the nurses' and pharmacists' perceptions and opinions of MAEs causes.

The findings show that expiry errors, a major component of procedural errors, take place across both psychiatric and community hospital ward types specifically when medication is given at the patient bedside and is prepared either in the clinic room or given via patient lockers, and that this is likely because of staff workload and/or lack of staff knowledge. The findings also suggest that omissions, a major component of clinical errors, were associated with the mixed mode of administration on psychiatric wards and the 12:00 administration time, and occurred because of a range of reasons that included workload, miscommunication and staff-related factors. Another type of clinical error was the wrong time error which was associated mainly with the patient lockers and the 08:00 administration time, mainly because of the high staff workload. The results suggest that patient lockers are not as safe as perceived because they are implicated in both clinical and procedural errors. In addition, the distinct contributing factors identified in this study can provide a means through which the occurrence of MAEs can be addressed.

Overall, in this study the findings offer an evidence-base to help enhance the understanding of the actual causes behind MAEs. Avoiding or modifying these factors could assist in decreasing the error rate and increase the quality of healthcare in this NHS Trust.

6.2 Reflexivity

The process of reflexivity is where a researcher is reflective about their own personal impact on their methods, values, knowledge, behaviour, biases, beliefs, and the relation with the participants which could affect the explanation of their responses (Bryman, 2012, Parahoo, 2014). Moreover, reflexivity acknowledges that researchers are part of the social environment under study, which emphasised an awareness of their role in constructing the knowledge that help the reader to understand the findings better (Parahoo, 2014, p. 385).

Furthermore, the purpose of being reflexive is to enhance the quality and validity of the research study, recognise the limitations of the knowledge that is produced, increase understanding of how positions and awareness as researchers affect all stages of the research process, and that will lead to more rigorous research (Primeau, 2003, Guillemin and Gillam, 2004).

In relation to reflexivity, in research studies using observational methodology, it is common that the researcher could become involved directly in the study process and still preserve a measure of objectivity. In addition, Mauthner and Doucet (2003), state that the researcher's personal and professional biography should be known because the research could be the outcome of these biographies.

I accomplished a BSc degree in pharmacy from King Saud University in Saudi Arabia in 2001, before achieving my MSc in Clinical Pharmacy International Practice and Policy from the School of Pharmacy, University of London, UK in 2011. I gained my professional experience during my job as a ward pharmacist that allowed me to know more about medications administration and wards practice and this gave me the opportunity to work with other healthcare professionals such as nurses and doctors. The

nature of my professional career as a ward pharmacist influenced my knowledge and experience that will have impacted on the study subject. Moreover, in the administration round, I ensured that the medication was administered to patients in appropriate way (the right patient, the right medication, the right dose, the right route, and the right time) (Balas et al., 2004), and gave help and advice on the medication administration.

Furthermore, before starting my PhD journey, I worked for two years as a manger of clinical services alongside my job as a manger of inpatient and outpatients' pharmacy in a hospital, which influenced my knowledge through challenging medication errors and medication administration errors in particular that gave me awareness of how it influenced the research process.

In addition, it could be argued that involvement in the study as an observer is a source of bias, however, I contend that it would be impossible to keep myself (the researcher) separated from the knowledge and experience that I have gained from my professional experience.

Moreover, during the research process I did not inform the participants about my professional experience as a pharmacist; I introduced myself to the participants as a PhD student and the main researcher. This allowed me to explore the participants' practice experiences on the medication administration observations freely. Likewise, in the interviews by presenting myself as a pharmacist I expected that participants would re-evaluate their answers and would reflect what they perceived I want to hear about the causes of MAEs so that I introduced myself to them as a PhD researcher only.

According to Mauthner and Doucet (2003), an important element of reflexivity is situating researchers socially and emotionally in relation to respondents that could identify with interpretations of their accounts.

During the observations and the interviews, I did not have difficulty or concerns in becoming involved in the UK society and culture as an international PhD student for two reasons. First, my professional experience and the training I had at UK Trust assisted me to understand the medication administration process as well as dealing with the healthcare professionals who participated in this study. Second, during my master degree study I lived in the UK for three years (2009-2011) I have increased my experience in UK culture which helped me to acquire more confidence in dealing with the participants.

As an example of reflexivity issue during the observation, I noted the following after observing one of the nurse participants:

> *"It is interesting how it could be helpful in recognising my thoughts and beliefs when writing notes during observation and doing analysis. This day was difficult for me due to a long time in observation the round which took more than two hours. Note: before starting the ward observation with a nurse, she was very busy with elderly patients doing other activity, beside that she looked tired, during the observation she was a bit annoyed and not feeling comfortable, at the end of the observation she apologised to me because she was under pressure due to the heavy workload. This made me think about whether there is a relationship between the nature of patients and workload and the potential of errors e.g. wrong time errors".*

6.3 Research limitations

Some limitations existed in this research study, as with all studies, which are highlighted as follows:

1- Regarding to the methodology limitations; qualitative data findings were based on healthcare staff (interviews) which are subjective by nature.

2- The study was only observed in one NHS Trust in the UK; more studies in other UK hospitals can examine whether the findings might be generalisable across the UK. Taking this fact into account; the findings of this study cannot be entirely generalised to all hospital sites.

3- There was almost a one year gap between the research observation and the staff interviews, and that might affect the interviewees' opinion due to some things changing in the administration practice during that year. The interview questions extracted general opinions about the cause of different type of errors and were not focused on specific causes.

4- The study sample of the nurses' interview participants was quite small number across the 19 wards (CHWs and PWs). Out of 19 nurses only 8 accepted to be interviewed, and there was no response from the other nurses. Also, the researcher decided to stop because there was no new data exported after the sixth interviewee.

5- The study sample for interviewing the pharmacists was small and limited. A larger sample could have provided more data. However, the sample size was enough to acquire their perceptions and did not limit this research as the target point was reached.

6- There might be a chance of bias because of involving the researcher in the study as an observer. However, observation is the only method that helped the

researcher to collect data on what actually happens in real practice and to gain a deep understanding of the phenomenon under the research study.

7- None of the drug administration mode observed at BHFT was shared across the two settings; different modes were confined to either PWs or CHWs. This therefore opens the possibility that observed effects could be influenced by setting rather than mode of drug administration.

8- The number of OE observed per ward was variable and included very low numbers for some wards. This led to significant variability in event rates even within particular modes of administration, which clouds judgement as to whether observed effects of mode of drug administration on MAE rates are accurate. This might be due to that each medication administration round was observed only once.

9- The link between WTEs and expiry errors and the bedside locker system was only seen on 3 out of 5 CHWs which showed that some observed relationships were not present on all CHWs using bedside-patient locker mode of administration.

6.4 Contribution to knowledge

This research study is one of the first to examine the rate and causes of MAEs within a mental-health and community hospital Trust in the UK which makes several novel contributions to knowledge.

For the methodological contribution, the methodology used in this research study established the applicability to compare mental-health and community hospital wards by using direct observation methods by adopting the mixed-methods approach. Moreover, in the quantitative inferential statistics, the use of Poisson

Regression for modelling the MAEs data proved its usability in this study. This research provided a unique contribution by focusing on the concept of MAEs within a healthcare domain, the differences between the modes of medication administration rounds, and the different research methodologies that have been adopted for recording MAEs.

The research study further contributed to the body of knowledge by triangulating the findings of the pharmacists' and the nurses' interviews perceptions with the researcher observation opinions for causes of MAEs. The key finding of this study is that patient lockers might be not as safe as perceived.

6.5 Recommendations

The aim of this study is to produce recommendations for improving medication administration practices in this type of setting. In the light of the research findings and the literature review, the following recommendations for improve medication administration practice and reduce MAEs are to be made for CHWs, PWs or both wards.

1- General recommendations for CHWs and PWs:

a) One of the recommendations to reduce medication administration errors is to improve nurses' training to learn from their mistakes, and improve the work environment by reducing the workload in order to avoid errors. Besides, improve the nurses' education (workshops on different types of medication administration errors) e.g. nurses should be aware of the higher risk of errors associated with non-psychiatric drugs. This could reduce some MAE causes such as situation violation and lapses which is connected to different types of error e.g. expiry errors, other reason errors, omissions and blank boxes.

b) Regarding work priority; the organisation could help to make the work more manageable for the current staff or to allocate adequate staff levels to support the work volume. For example, some nurses could have more training courses to enhance their skills and knowledge to be able to manage their work priorities which could reduce the issue of work pressure. The education training interventions and their relation in reducing MAEs have been examined by (Keers et al., 2014) which illustrated the advantages of the nurses training in different wards. Also, Dawson (2014) showed how training decreased MAE rate in mental-health wards.

c) Another recommendation is to increase nurses' skills of double-checking the drug chart by themselves in order to make sure that every drug is given and signed during the medication administration rounds and this could reduce some MAE e.g. (omission and blank boxes) which were caused by lapses.

d) Double-checking by two nurses would increase the accuracy of the medication practice which is recommended to administer the medications safely and reduce the error rate of MAEs. Also, it could improve the nurses work pressure and their concentration on drug charts during the administration, and could reduce different types of errors such as omission, blank boxes, wrong dose and other reason errors. The relation between double-checking and reduce the errors have been investigated by Alsulami et al. (2012) which showed a positive impact, however, this needs more examinations due to low evidence. In addition, Alsulami et al. (2014) showed the nurses lack of awareness of double-checking and stated that double-checking training could improve the nurses' knowledge and patient safety.

e) The electronic prescribing medication administration system (EPMA) was launched in September 2017 in the BHFT. It is recommended that the use of technology such as electronic prescriptions could help to reduce the MAEs e.g. wrong dose, wrong drug and omission. It also might improve some contributing factors such as the written miss-communication. However, further study is needed to compare the impact of EPMA on MAEs in BHFT. The benefit of using electronic prescribing in reducing MAE rates was also mentioned in previous literature in general hospital site (Franklin et al., 2007). On the other hand, Keers et al. (2014) showed the effect of other technology intervention in minimising of MAEs, and Cottney (2014) illustrated how the automated dispensing cabinet reduced the MAE rate and WTE in a psychiatric ward setting.

f) 'Staff workload' is considered to be the main contributory factors of different active failure; to make sure nurses are not interrupted or distracted during the medication administration, it is recommended on the wards to use verbal announcements for patients and visitors besides the 'do not disturb' sign which is already applied during the drug round in some BHFT wards. This might reduce most of MAE types. Raban and Westbrook (2013) showed the evidence of the interventions efficiency in decreasing the interruptions rate and different types of interventions to reduce the interruptions such as noticeable quiet zones for medication preparation and sign asking to not be interrupted when the nurses are administering medications etc.

g) Regarding to the safety culture issues, this can be enhanced by adapting the recommendations above e.g. training program, etc. as it is the organisation's responsibility to provide continuing education to the nurses. On the other

hand, nurses also have a responsibility to increase their own sense of the safety by learning about the different type of MAEs and the reason behind these errors, and trying to reduce or not to be involved in these errors. Also, nurses should take responsibility to learn the importance of organising their work priority by focusing only on drug administration rounds, and following the administration procedure by e.g. reporting any MAEs detected during the administration round which could help in reducing different type of errors. This might occur by motivating the nurses as shown in a study by Cottney (2015) where the ward missing the fewest doses received a prize. In addition, re-auditing the wards regularly by observing MAEs could encourage the nurses to enhance their safety culture and reduce the MAEs rate as illustrated in a study by Dawson (2014).

The above recommendations can be applicable for both wards CHWs and PWs as it needs similar suggestions for most error types which were also reflected from the study results. Moreover, some of the interventions that were mentioned in the participants' interviews, for example, training, double-checking and reducing the interruption and distraction are considered to be an important recommendation to take into account in this research study.

2- Specific recommendations:

a) Relating to the modes of administration in CHWs; using the drug trolley administration mode is highly recommended and it is more effective with the less risk of errors compared to the other mode. This might minimise the workload pressure which is responsible for most of the active failure condition.

b) Relating to the modes of administration in PWs; continuing to use the queueing administration mode is recommended. Also, it is more effective with the less risk of errors compared to the other modes. Drug trolley mode of administration is recommended to use in the older adult and learning disability wards than using bedside-prepared in clinic room mode due to the nurse difficulty dealing with patients' queueing. In addition, reducing or/and terminating mixed between two modes could also decrease the risk of errors. This could show the advantage of reducing the workload that is responsible for most of the active failures.

c) To reduce the WTEs in the 08:00 rounds for both sites (CHWs and PWs), it is recommended that the medication which the patient takes it once daily not to be given this time unless it is necessary. This could be achieved by arranging between the prescribers and the administered nurses in order to decrease the time taken to administer a lot of medications.

d) One other recommendation for both sites is to slightly shift the 12:00 administration round so that it is not exactly at the same time as lunch as this study showed that all of 12:00 observations were busy with other activity (patient lunchtime), and so a reasonable change might be achieved by administer medications after the lunchtime. This could reduce the risk of clinical errors such as omissions.

6.6 Future research work

According to the presented research study findings; it is apparent that there is a need for further research into the causes of MAEs. Similar research in other countries could enable comparative studies in the area with similar research objectives and adopting the same methodology which would gather more findings and perceptions.

The following are suggestion for further research which would be an interesting avenue to explore in future work:

1- This study sample was in one NHS Trust, further research to observe MAEs on other UK hospitals is needed, where it could help to present more and different findings and perceptions.

2- Future work could have more quantitative data e.g. (questionnaire) to study the nurses' participant satisfaction and other views about the mode of administration in a 'standardised' way.

3- It could be advised in future work to interview a larger sample of nurses and pharmacists in order to gather more in-depth data by asking more specific questions. For example, questions about the reason behind the active failure that caused different type of errors.

4- As the EPMA is launched in September 2017 at the BHFT, future work could observe the use of technology e.g. electronic prescriptions in medication administration process as well as its effect on MAEs and compare the results with the current study data.

5- Future work could be directed to use interventions which could be adapted from these research recommendations, and study the post-interventions to measure the impact of these recommendations. For example, observe the MAEs in both

hospital sites after launching a nurse's training program and workshops which include awareness about different type of errors as well as managing the work priorities skills and knowledge, and comparing the results with the current study data. Also, observing MAEs after adapting a double-checking awareness/implementation intervention would be useful. Another example would be to observe the interruptions and the MAEs after developing an intervention for reducing interruptions and comparing the overall data.

6- Further investigations are also needed in terms of how to encourage nurses to strengthen their belief in the safety culture and testing its effect on MAEs.

7- A quantitative data collection (e.g. using a survey) could be completed as future work in both hospital sites to measure the nurses' extent of knowledge about different types of errors, e.g. the agreement of specific behaviours as types of errors which help to map the training program.

8- Future research could also be completed by observing the MAEs focusing in specific PWs and CHWs. For instance, selecting wards that had the highest MAEs rate from both hospital sites and observing the four administration rounds for each ward not only once. For example, by comparing the MAEs results at 8:00 administration round in all wards. This will provide more opportunity to collect data in each selected ward over a shorter time.

9- Future research could also be completed by observing the MAEs in CHWs using the patient locker mode of administration to seek the relationship between WTEs and the bedside-patient locker mode of administration. If it is still shows similar results, more future work is needed to implement drug trolleys in these wards and again observe the MAEs.

10- Future work can also be completed on MAEs observation study after implementing the drug trolley administration mode in older adult PWs and learning disability wards and comparing it with current study results.
11- Future work can also be completed after decided the appropriate decision on delivering the not necessary once daily medication from 8:00 administration time to other administration time by comparing the MAEs observation results with the current results.
12- Observing the MAEs after postponing the 12:00 administration round and comparing the overall results can be as future work.
13- Future work plan after the PhD, include publication by separating out data from community and psychiatric hospitals to recognise clearly the differences between these sectors, as well as deeply analysing the data recorded on patient level information such as prescribed medications, gender and age.

6.7 Future career work

As I am one of the clinical pharmacists' team working at King Fahad Armed Forces Hospital in Jeddah, Saudi Arabia, it is very important to consider the work plan following my PhD study into this hospital. King Fahad Armed Forces Hospital is a secondary care hospital included different general wards such as (surgical, medical, cardiac etc.). One of the future work plans is to implement similar study methodology in these wards taking precautions to avoid the limitations found. This could help to test the medication administration practice in the hospital that has not been tested until now, besides the results might help to increase the medication safety awareness in this setting.

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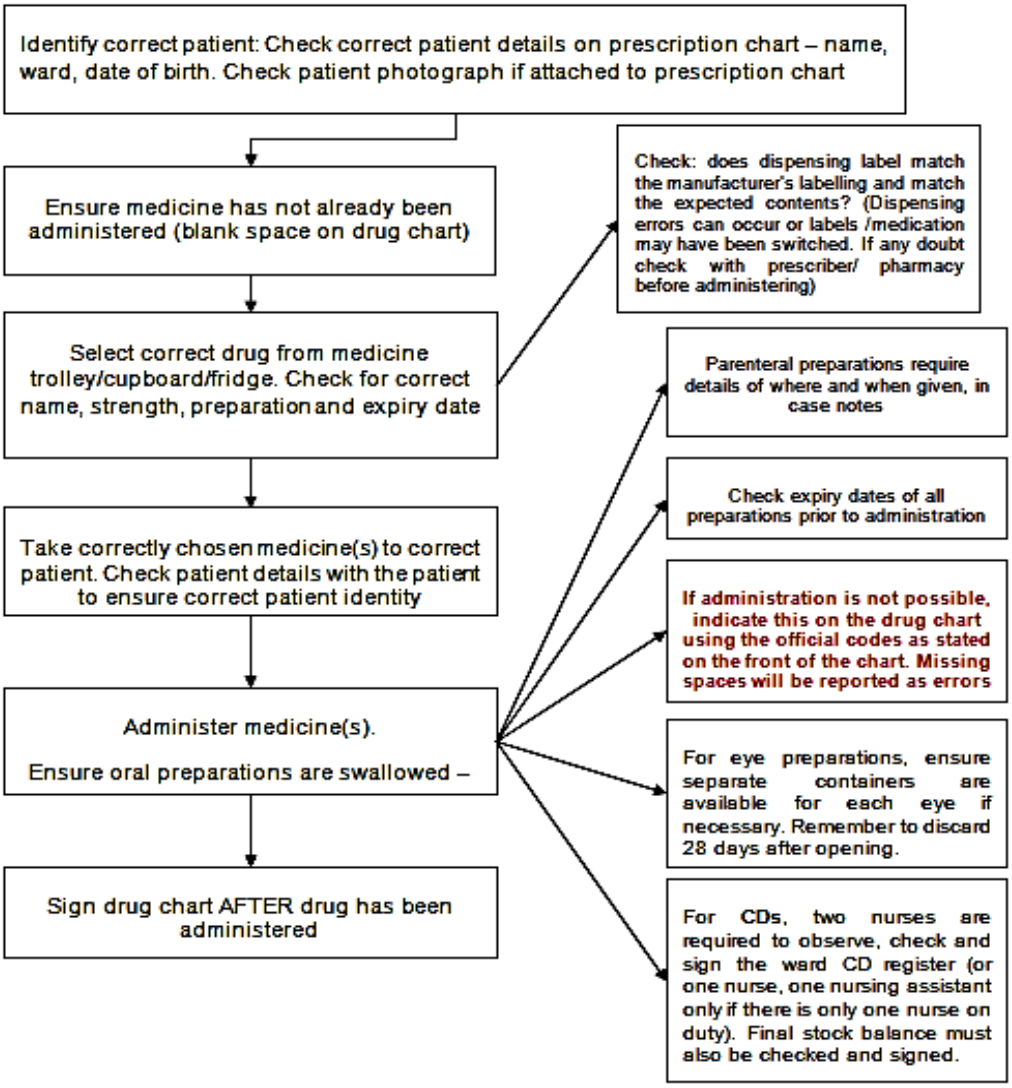
Appendices

Appendix 1 Process of the medication administration

MRSOP:4005 Administration of Medicines (v.1.2)

Processes for the Administration of Medication

- Only qualified Nurses and Doctors can administer medication within BHFT.
- Administration mainly applies to Hospital In-Patients so the administration record will be the In-Patient Drug Chart. Stationery approved by the BHFT chief pharmacist should be used if medicines are administered to Community or Outpatients under the care of Home treatment or Community Teams.



These processes must be followed in conjunction with background information on Medicine Administration as described in this SOP and in the Care and Control of Medicines Policy CCR006.

Appendix 2 BHFT SOP around administration of critical medicines

List of Critical Medicines

NPSA alert from 2010 'Reducing harm from omitted and delayed medicines'
(http://www.nrls.npsa.nhs.uk/resources/type/alerts/?entryid45=66720&p=1**)** (1)

This states that we need to identify a list of critical medicines where timeliness of administration is crucial. Critical medicines are those where the omission or delay is likely to cause the most harm. This is usually defined as needing to be administered within 2 hours of the prescribed time.
This list should include anti-infectives, anticoagulants, insulin, resuscitation medicines and medicines for Parkinson's disease, and other medicines identified locally;
'A national list of critical medicines was not recommended. This was because medicines considered critical in one hospital (for example a children's hospital) may differ significantly from another hospital, such as a cancer hospital or mental health hospital. The answer was to provide flexibility for NHS organisations to identify a list of critical medicines that address local risks and add these to the list proposed by the NPSA.'
This list has been adapted from the original approved list (unreferenced) in MRSOP 4008 using the NPSA guidance and critical medicines lists from other NHS Trusts (2,3,4)

Medication	Possible consequence of omission or delay	Commonly used examples of these drugs
Analgesics	Loss of pain control	Codeine, ibuprofen, diclofenac, naproxen, oxycodone, morphine
Anti-cancer drugs	Treatment failure	See BNF
Anticoagulants (e.g. warfarin, heparin, low molecular weight heparins)	INR reduced, resulting in increased blood clotting e.g. DVT or PE	Warfarin, rivaroxaban, dabigatran, tinazaparin, dalteparin, enoxaparin, heparin
Anticonvulsants for use in epilepsy	Loss of seizure control	Sodium valproate, carbamazepine, lamotrigine, phenytoin, topiramate, gabapentin, levetiracetam
Antidepressants (specifically Paroxetine, venlafaxine, tranylcypromine)	Withdrawal symptoms	Paroxetine, venlafaxine, tranylcypromine
Anti-infectives (antibiotics, antifungals and antivirals)	Treatment failure and/or development of resistance	Amoxycillin, flucloxacillin, ciprofloxacin, fluconazole, trimethoprim, tenofovir, stavudine, nelfinavir, ritonavir
Drugs used in substance misuse	Withdrawal symptoms	Buprenorphine, Chlordiazepoxide, lofexidine,
Clozapine	Loss of symptom control; if omitted for more than 48 hours dose must be re-titrated from 12.5mg to avoid serious adverse effects e.g. hypotension, seizures.	Clozapine
Glaucoma eye drops	Increased intra-ocular pressure – possible	Cartelol, timolol, latanoprost,

	blindness	dorzolamide, pilocarpine,
Insulin and oral hypoglycaemic agents	Hyperglycaemia - problems may be avoided by implementing practical solutions (e.g. for Insulin, link administration to when food will be actually eaten). Promote self administration if safe and appropriate to do so.	Insulins - all
Parkinsons disease	Loss of symptom control	Co-carbidopa, co-careldopa, madopar, sinemet. Pramipexole, pergolide, cabergoline
Lithium	Loss of symptom control, invalid test results	lithium
Oxygen	Increased risk of harm from prolonged hypoxia	oxygen
Resus/emergency medication including Rapid tranquilisation medicine	Increased mortality or increased risk of harm to patient, fellow patients and staff	Resus medication, Hypostop, glucagon, glucose, Flumazenil, Calcium resonium, glucose/ insulin, naloxone
Doses pre therapeutic drug monitoring	In order for the results of TDM tests to be meaningful the timing of the last dose must be accurate.	Lithium, clozapine, digoxin, carbamazepine, warfarin
Other drugs deemed critical by the Pharmacist (in conjunction with the MDT) and annotated as such on the prescription chart		May include: Anti-hypertensives Anti-arrhythmic – cardiac drugs Digoxin Corticosteroids Immunosuppressants Nebulised bronchodilator therapy Regular benzodiazepines (short-acting) Methylphenidate immediate release

1. NPSA alert from 2010 ‘Reducing harm from omitted and delayed medicines’ (http://www.nrls.npsa.nhs.uk/resources/type/alerts/?entryid45=66720&p=1)
2. Surrey and Borders Partnership Trust, Appendix 4 RRR Omitted and delayed medicines
3. Royal Cornwall Hospitals NHS Trust, Delayed and Omitted medicines procedure version 1.2, February 2013 (accessed via google 09.10.14)
4. Devon Partnership NHS Trust, Medicines Management Briefing 11-005 9 (July 2013)

Appendix 3 Observations rota

Schedule for observations of medication administration rounds— please display this chart in a visible area *(Contact: p.donyai@reading.ac.uk / 0118 378 4704)*

Wards	Day and time			
Daisy	Monday 6th July **6pm**	Friday 31st July **10pm**	Thursday 27th Aug **Noon**	Thursday 24th Sept. **8am**
Rose	Tuesday 7th July **8am**	Monday 3rd Aug. **6pm**	Friday 28th Aug. **10pm**	Friday 25th Sept. **Noon**
Bluebell	Wednesday 8th July **Noon**	Tuesday 4th Aug. **8am**	Tuesday 1st Sept. **6pm**	Monday 28th Sept. **10pm**
Rowan	Thursday 9th July **10pm**	Wednesday 5th Aug. **Noon**	Wednesday 2nd Sept. **8am**	Tuesday 29th Sept. **6pm**
Orchid	Friday 10th July **6pm**	Thursday 6th Aug. **10pm**	Thursday 3rd Sept. **Noon**	Wednesday 30th Sept. **8am**
Campion	Monday 13th July **8am**	Friday 7th Aug. **6pm**	Friday 4th Sept. **10pm**	Thursday 1st Oct. **Noon**
Sorrell	Tuesday 14th July **Noon**	Monday 10th Aug. **8am**	Monday 7th Sept. **6pm**	Friday 2nd Oct. **10pm**
Snowdrop	Wednesday 15th July **10pm**	Tuesday 11th Aug. **Noon**	Tuesday 8th Sept. **8am**	Monday 5th Oct. **6pm**
Oakwood Beech	Thursday 16th July **6pm**	Wednesday 12th Aug. **10pm**	Wednesday 9th Sept. **Noon**	Tuesday 6th Oct. **8am**
Oakwood Elm	Friday 17th July **8am**	Thursday 13th Aug. **6pm**	Thursday 10th Sept. **10pm**	Wednesday 7th Oct. **Noon**
Oakwood Willow	Monday 20th July **Noon**	Friday 14th Aug. **8am**	Friday 11th Sept. **6pm**	Thursday 8th Oct. **10pm**
Ascot	Tuesday 21st July **10pm**	Monday 17th Aug. **Noon**	Monday 14th Sept. **8am**	Friday 9th Oct. **6pm**
Windsor	Wednesday 22nd July **6pm**	Tuesday 18th Aug. **10pm**	Tuesday 15th Sept. **Noon**	Monday 12th Oct. **8am**
Donnington	Thursday 23rd July **8am**	Wednesday 19th Aug. **6pm**	Wednesday 16th Sept. **10pm**	Tuesday 13th Oct. **Noon**
Highclere	Friday 24th July **Noon**	Thursday 20th Aug. **8am**	Thursday 17th Sept. **6pm**	Wednesday 14th Oct. **10pm**
Henry Tudor	Monday 27th July **10pm**	Friday 21st Aug. **Noon**	Friday 18th Sept. **8am**	Thursday 15th Oct. **6pm**
Jubilee	Tuesday 28th July **6pm**	Monday 24th Aug. **10pm**	Monday 21st Sept. **Noon**	Friday 16th Oct. **8am**
Little House	Wednesday 29th July **8am**	Tuesday 25th Aug. **6pm**	Tuesday 22nd Sept. **10pm**	Monday 19th Oct. **Noon**
BAU	Thursday 30th July **Noon**	Wednesday 26th Aug. **8am**	Wednesday 23rd Sept. **6pm**	

Appendix 4 Standing operating procedure

Medication Administration Errors (MAEs)
The medicine administration is considered to be associated with a significant proportion of identified errors, for example 44% of overall medication errors are thought to be related to administration errors (Leape et al., 1995). The NPSA (NPSA, 2010) reported that 27 deaths, 68 severe harms and nearly 21,000 other patient safety incidents were associated with omissions or delays in medicines administration within three years.

A medication administration error (MAE) can be defined as: *"Any deviation between the medication prescribed and that administered",* in line with previous studies where medication prescribed is defined as: *"Medication currently on the patient's regular (repeat) list, plus any changes and acute medication recently prescribed"* (Barber et al., 2009). Therefore, MAE considered as any dose of drug administered or omitted that regress from the patient's recent prescriptions (Barber et al., 2009).

Opportunity for error (OE) is counted as any dose of medication that is observed either being administered or omitted, which could be classified as being either correct or incorrect (Taxis and Barber, 2003).

Observation of Medication Administration

The plan:

I will observe 170 medication administration rounds (two each day during the working week, for each ward. Four drug rounds normally take place each day on all but the adolescent wards at the Trust. The data will be collected prospectively by observing nurses during medication administration rounds. I would like to observe a sufficient number of ward rounds to enable me to effectively pick up any medication administration errors and practice deviations that might occur.

The reason:

The study will examine medication administration errors and staff perceptions. These will enable me to make recommendations about ways of improving medication administration practices across the Trust.

Before the drug round

- I will take everything I need i.e. identification (hospital ID badge), data collection forms, pens, spare paper, BNF and consent forms, personal alarm.
- I will arrive on the ward before the time that the round is likely to begin that would give me the opportunity to check through the drug trolley before observing the drug round; to note what will administered to the patients. Doing this on the same day as the observation will be best but if this is not possible, it can be done the previous day.
- I will introduce myself to the ward manager or the nurse in charge and wait at the nursing station for the drug round to begin.
- I will explain that I am a researcher, and what I would like to do (ensure that the nurse understand what I intend to do even if they have already consented).
- Remind staff that the purpose of this study is to observe medication administration rounds in order to identify adherence (or non-adherence) to

prescribed medication – i.e. to see whether medicines are given exactly according to the prescription in all instances and what reasons exist when there are deviations. After the observation phase, I would then like to explore the views of health professionals (nursing staff) about practice deviations.

- I will ask if they would mind to accompany on this drug round.

If the nurse is happy to be observed, I will explain what I will do. For example:
"I will shadow you from when you start the round; I will make notes relating to which medicines have been prescribed for each patient and which medicines have been administered by you. You don't need to do anything different to your normal practice, other than allow me to observe what you normally do during a medication round. The only purpose is to make a comparison across different wards. All results will be anonymous, and it will not be possible to identify individual members of nursing staff from the results."
If a nurse does not want to be observed I will document this and try and come back another time to observe another round.

During the drug round:

- I will shadow the nurse administering medication during the drug round. If the nurse is called away for any reason from the trolley I will stay with the drug trolley as I should be able to collect all of the applicable data.
- I will try to be friendly to the nurses. However, if they asked for advice about drug administration, I will explain that I am a researcher, so I cannot assist with patient care. (If I feel that the patient's might suffer harm if I do not give an advice, then I will go ahead and give whatever advice is necessary).
- During the drug round I will record all doses that I observe to be given (or should be given but was not) by using the data collection form. MAE will documented and any accompanying details will also be recorded happen i.e. if MAE is prevented by myself or by a patient.
- It is known that the administration rounds move very quickly, so I will use abbreviations during the round to catch everything then I will clarify any details afterwards.

"When a dose is omitted during the drug round but the drug chart is signed to indicate that it has been administered, count this as an omission as we will assume that the dose is never given. However if a dose is omitted and the drug chart left blank, I should ask the nurse at the end of the round whether the drug was intentionally omitted. If the omission was unintentional, again, this should be included as an OE and an omission error." (Barber et al., 2009).

After the drug round:

After the drug round is over, I will thank the nurse. Then I will check different things that I could need such as; check that the drug chart and dispensing label agree, check whether or not the medicines have been signed for by ticking in the proper column, check for the expiry dates on medicines. (Barber et al., 2009).

Form for recording observations of medication administration rounds

Other ward activity? (meal/ward meeting/ ward round/ tea break/other)	
Staff members down?	
Mode of administration – bedside/queue?	
Permanent or bank?	

Date:	Time – circle				Medication round start time:	Medication round finish time:	Observation number:
	AM	Noon	6pm	Night			
Ward name:	Day of week:						

Patient initials	Error or near-miss? (Yes/No)	Medication name, strength, form, dose	Error type										Storage	Interruption type (patient, staff, other activities)
			O*	AE	EDs	WD	UD	DI	FE	RE	DD	WTE	Other	
e.g. A.M	e.g. Yes													

O*: if the box left blank it will consider as omission error (no sign or codes as follows): A = Absent without leave, C = Covert administration of medicine, E = Omitted prior to ECT, L = On leave, N = No stock, P = patient managing their own medicines, R = Refused, S = Sleeping, AS = Self administration, X = Prescribed omission, O = Omitted for another reason, or T = On another ward/ at another hospital, which must be recorded in the patient's notes

Appendix 5 Interview questions

The main purpose of this questionnaire is to find out

Confirm whether the participant needs to read the "participant information sheet" again.	
Request permission from the participant to audio-record the interview.	
Inform the participant that all the information that will be recorded in the interview will be treated confidentially.	
Ask the participant to complete the consent form and give the participant a copy.	
Check whether the participant has any further questions or needs any further information before starting the interview.	

- Whether the nurses agree that a particular type of activity coded as an MAE is actually a medication administration error?
- How the nurses judge the impact of the different types of MAE.
- What the nurses believe are contributing factors to the different types of MAEs
- Whether the nurses have any opinions about the types of interventions that can reduce MAEs

Brief chat:

My name is Hesham and I am a PhD pharmacy practice student at the University of Reading. From the email that the ward manager sent, you indicated your interest to be interviewed regarding nurses opinions about the reasons behind medication administration errors within the Trust. Thank you for agreeing to participate. Hopefully this interview will take not more than 20-30 minutes of your time.

During my observational visit on the psychiatric and community hospital wards I made a number of observations for which I wanted to seek some clarity, especially around why and if certain decisions were made because I was not able to form an opinion on what I found.

- One of the most frequently encountered situations that I found was potentially relating to the omission of medication. According to my own notes, I observed 49 cases where the medication was, *to me*, not given and the drug chart was also not signed either. However, I must stress that these were my observations and that the whole purpose of these interviews is to see if there could be some other practice or explanation of what I think I found. If I count what I observed as an omission then these are considered to be 'blank boxes' on the drug charts so it's important for me to get a sense of whether my observations are likely to have been accurately interpreted or not.

Some of the products were topical such as E45 cream, fucidin cream, clotrimazole cream and epaderm cream, bactroban nasal ointment and diprobase cream and some were oral products such as vitamin B compound, procal shot, flucloxacillin, diazepam, paracetamolas well as metformin.

1) Do you agree in principle that forgetting to give the medication and not signing the drug chart should be coded as a medication administration error?
2) What do you think a blank box is? (Nurse forgot to give or nurse gave but forgot to sign? Have you come across similar examples in the past?
3) Some omitted topical as well as oral medication (E45, paracetamol). Why do you think that such omissions happen?
4) Following your answer, do you think that there is ever any priority for giving some medications more than others?
5) During my observation, I found that some medication such as fucidin cream or flucloxacillin were forgotten to be given on more than one occasion during my observation. To what extent do you think this could harm the patient? Another common error was with vitamin B compound or thiamine – what about this type of medication?
6) What might help reduce the occurrence of this type of medication administration error?

- Another example, I found 19 cases where the medication appeared *to me* not given however, the drug chart was actually signed to say that it was given. Most of these instances involved topical products.
  1) Therefore it seemed to me that the nurses involved signed the drug chart without giving the medication to the patient. Could this happen?
  2) Do you agree in principle that forgetting to give the medication and signing the drug chart to say that it has been given should be coded as a medication administration error?
  3) Why do you think this sort of error could happen?
  4) What would be the impact on the patient?
  5) What would help reduce the occurrence of this type of medication administration error?

- In another 19 cases the medication was at first not going to be given unless I intervened to remind the nurse.
  1) For example: in some cases the nurses involved giving all the patients' medications but they forget to give one or two items then I intervened to remind them, in your view is it possible that this could happen?
  2) Other example: the nurses involved did not give the medication due to the patients were not in their room and the nurse decided to return back to patient to give the medication but it seemed to me that they forgot then after my intervention they return to give medication to the patient in your view it's possible that this could happen?
  3) Do you agree in principle that forgetting to give the medication from the first time should be coded as a medication administration error?
  4) Why do you think this sort of error could happen?
  5) What would be the impact on the patient?
  6) What would help reduce the occurrence of this type of medication administration error?

- During my observation there were 18 cases where the medication was given but the nurse possibly forgot to sing the drug chart, which is considered to be a 'blank box' on the drug chart.
  1) Therefore it seemed to me that the nurses did not sign the drug chart but did give the medication to the patient. Could this happen?
  2) Do you agree in principle that giving the medication but not signing the drug chart to say that it has been given should be coded as a medication administration error?
  3) Why do you think this sort of error could happen?
  4) What would be the impact on the patient?
  5) What would help reduce the occurrence of this type of medication administration error?

- According to the Trust policy that opening date should be labeled for some drugs formulations such as (liquid, eye drops and insulin) due to different half-life and expiry dates to these medications (liquid up to 3 months and eye drops and insulin 28 days from opining date. 118 cases were the medication appear *to me* with no opening and expiry date label.
  1) Therefore it seemed to me that the nurses could possibly forget to write the opening date for this medication, Why do you think this might happen? (By mistake or on purpose?)
  2) In some cases I found that tablet given from the strip that did not include the expiry date, do you think that matters?
  3) Do you agree in principle that giving the medication from container did not have label to show the opining or expiry date should be coded as a medication administration error?
  4) Why do you think this sort of error could happen?
  5) If you find an expired medication given by a nurse. What would be the impact on the patient?
  6) What might help reduce the occurrence of this type of medication administration error?

- In addition, there were other cases found potentially relating to MAE's such as 57 cases (other reason error), 47 cases (wrong time error) and 24 cases (wrong dose).
  1) Rinse mouth after using some corticosteroid inhalers were the most error detected for other reason. Therefore it seemed to me that the nurses might forget to tell the patients to rinse their mouth after using the inhaler. Could this happen?
  2) Do you agree in principle that did not rinse the patients mouth after giving the corticosteroid inhalers should be coded as a medication administration error?
  3) Why do you think this sort of error could happen?
  4) What would be the impact on the patient?
  5) What would help reduce the occurrence of this type of medication administration error? How could we raise the profile of this type of error with the nursing staff?
  6) Regarding the time of administration round, from your experience, could some administration round take more than 2 hours?
  7) Do you agree in principle that giving medication after 2 hours should be coded as a medication administration error? (For example paracetamol 1 gm 4 times daily)
  8) Why do you think this sort of error could happen?
  9) What would be the impact on the patient?
  10) What would help reduce the occurrence of this type of medication administration error?

11) One of the most concerning situations I found that some nurses were attempting to give heparin 5000 units 0.25ml instead of 0.2ml? It is written on the box that 5000 units = 0.2ml. This was observed on more than one occasion but do you think this. Could this happen?
12) Do you agree in principle that giving the wrong dose of medication should be coded as a medication administration error?
13) Why do you think this sort of error could happen?
14) What would be the impact on the patient?
15) What would help reduce the occurrence of this type of medication administration error?

- During the observation, I noticed some wards were very busy with other activity such as (ward meeting, Dr round and other).
  1) From your point of view, what is your priority during the drug administration round? And why?
  2) I found some nurses priority were other activity (Dr round)? Why?

- During my drug administration round, one of the nurses told me that the drug administration is routine work, and that they are fed up of drug administration.
  1) In what extent do you agree with them? And why?

- From the observation data collection the rate of error found was 16%, do you think that rate could be minimised and how?

Thank you very much for your valuable time and information.

Give the participant the amazon voucher

Appendix 6 The University of Reading's Research Ethics Committee and the Trust's Clinical Audit Department Approval

University of Reading

Coordinator for Quality Assurance in Research
Dr Mike Proven, BSc(Hons), PhD

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email m.j.proven@reading.ac.uk

Dr Parastou Donyai
School of Chemistry Food and Pharmacy Sciences
University of Reading
RG6 6AP

13 June 2014

Dear Parastou

UREC 14/18: A service evaluation of one stop dispensing using patient lockers for medicines on a Mental Health ward (Daisy Ward).
Favourable opinion

Thank you for your revised application (your email dated 13 June refers). I can confirm that the Chair is pleased to confirm a favourable ethical opinion on the basis of this revised documentation.

Please note that the Committee will monitor the progress of projects to which it has given favourable ethical opinion approximately one year after such agreement, and then on a regular basis until its completion.

Please also find attached Safety Note 59: Incident Reporting in Human Interventional Studies at the University of Reading, to be followed should there be an incident arising from the conduct of this research.

The University Board for Research and Innovation has also asked that recipients of favourable ethical opinions from UREC be reminded of the provisions of the University Code of Good Practice in Research. A copy is attached and further information may be obtained here: http://www.reading.ac.uk/internal/res/QualityAssuranceInResearch/reas-RSqar.aspx.

Yours sincerely

Mike Proven

Dr M J Proven
Coordinator for Quality Assurance in Research (UREC Secretary)
cc: Dr John Wright (Chair); Professor Helen Osborn (Head of Department); Mrs Cat Hale (Research secretary)

University of Reading

Coordinator for Quality Assurance in Research
Dr Mike Proven, BSc(Hons), PhD

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Dr Parastou Donyai
School of Chemistry Food and Pharmacy Sciences
University of Reading
RG6 6AP

13 June 2014

Dear Parastou

UREC 14/18: A service evaluation of one stop dispensing using patient lockers for medicines on a Mental Health ward (Daisy Ward).
Favourable opinion

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Yours sincerely

Mike Proven

Dr M J Proven
Coordinator for Quality Assurance in Research (UREC Secretary)
cc: Dr John Wright (Chair); Professor Helen Osborn (Head of Department); Mrs Cat Hale (Research secretary)

University of Reading

Coordinator for Quality Assurance in Research
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Dr Parastou Donyai
School of Chemistry Food and Pharmacy Sciences
University of Reading
RG6 6AP

30 January 2015

Dear Parastou

UREC 14/18: An audit of medication administration rounds at Berkshire Healthcare NHS Foundation Trust using observational methods. *Amendment favourable opinion*

Thank you for the application (email, including attachments, dated 10 December 2014 refers) requesting amendments to the above project (*changed title; extended scope (to include all Trust wards); modified data collection*). I understand that the amendments have been approved by nursing staff and ward managers in the Trust. I can confirm that the UREC Chair has reviewed the request and is happy for the project, as described in the revised protocol, to continue with UREC approval.

Yours sincerely

Mike Proven

Dr M J Proven
Coordinator for Quality Assurance in Research (UREC Secretary)
cc: Dr John Wright (Chair); Professor Helen Osborn (Head of Department); Mrs Cat Hale (Research secretary)

University of Reading

Coordinator for Quality Assurance in Research
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Dr Parastou Donyai
Director of Pharmacy Practice
School of Chemistry Food and Pharmacy Sciences
University of Reading
RG6 6AP

5 September 2016

Dear Parastou

UREC 14/18: An audit of medication administration rounds at Berkshire Healthcare NHS Foundation Trust using observational methods. *Amendment favourable opinion*

Thank you for the application (email, including attachments, dated 12 August 2016 refers) providing documentation and requesting amendments to the above project (*project interview schedule; request to amend follow-up interview arrangements to include nurses only*). I can confirm that the UREC Chair has reviewed the request and is happy for the project to continue with UREC approval.

Yours sincerely

Mike Proven

Dr M J Proven
Coordinator for Quality Assurance in Research (UREC Secretary)
cc: Dr John Wright (Chair); Dr Rebecca Green (Head of Reading School of Pharmacy)

Berkshire Healthcare NHS
NHS Foundation Trust

Clinical Audit Department
5th floor, Fitzwilliam House
Skimped Hill Lane
Bracknell
RG12 1LD
Tel: 01344 415823
Email: jennifer.knight@berkshire.nhs.uk

11th June 2015

Hesham Arafah Abduldaeem

C/O Pharmacy Dept, PPH.

Dear Hesham,

An audit of medication administration rounds at BHFT using observational methods

Thank you for sending us your project proposal *An audit of medication administration rounds at BHFT using observational method.*

The clinical audit department has carefully reviewed the different aspects of your proposed project from the proposal form submitted by yourself. Following review, the audit department has approved the project, subject to the following terms:

- Letter of access issued.

This project has now been registered and placed onto the audit department's database. Your unique project number is ID 2733, please use this number on any correspondence you may use, including any forms, this will help the audit department ascertain which audit the correspondence relates to.

Should you require assistance at any stage of your project please do not hesitate to contact the clinical audit department on the above details.

Please send a copy of your final report to the Clinical Audit Department for the Trust's records.

We wish you every success with the project.

Yours sincerely

Jen Knight
Clinical Audit Department

Healthcare from the heart of your community

Berkshire Healthcare NHS
NHS Foundation Trust

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5th floor, Fitzwilliam House
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Email: jennifer.knight@berkshire.nhs.uk
11th June 2016

Dear: Mr Hesham Arafah Abduldaeem

Re: Letter of Access for Evaluation - An audit of medication administration rounds at BHFT using observational methods (ID:2733)

Further to your previous letter of access dated 11th June 2016, Berkshire Healthcare NHS Foundation Trust confirms your right of access to conduct evaluation through the organisation for the purpose and on the terms and conditions set out in the original letter, is extended. This right of access commences on 11th June 2016 and ends on 11th December 2017 unless terminated earlier in accordance with the clauses as previously noted.

Yours sincerely

Clinical Audit Dept.

cc: Line Manager/Supervisor, BHFT
HR department of the substantive employer

Appendix 7 Notice about presence of PhD researcher on the ward

Notice about presence of PhD researcher on the ward

There is a PhD researcher from the University of Reading on this ward observing normal practices, including giving out medicines. If you wish for the researcher to not look at your medicine chart then please let one of the nurses know.

Appendix 8 Letters of information for consent to participate in observations and interviews

Doctoral student
Mr Hesham Abduldaeem BSc, MSc
h.a.a.abduldaeem@student.reading.ac.uk

Lecturer, Pharmacy Practice
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Letter of information for consent to participate in observations

Title of Study: An audit of medication administration rounds at Berkshire Healthcare NHS Foundation Trust using observational methods

Invitation

I would like to invite you to take part in a research study. Before you decide I would like you to understand why the research is being carried out and what it would involve. If you need any clarification after reading this Information Sheet, I can arrange to meet and go through the information sheet with you in order to answer any questions you have – please see the header of this Information Sheet for my contact details. I expect that this information sheet should take about 5 to 10 minutes to read through

Part 1 tells you the purpose of this study and what will happen if you take part.

Part 2 gives you more detailed information about the conduct of the study.

Please feel free to contact me if there is anything that is not clear.

Part 1 of the information sheet

What is the purpose of the study?
I am conducting an audit of medication administration rounds across all wards at BHFT. I would like to establish practices against national standards. The purpose of this study is to observe medication administration rounds in order to identify adherence (or non-adherence) to prescribed medication – i.e. to see whether medicines are given exactly according to the prescription in all instances and what reasons exist when there are deviations. After the audit, I would then like to explore the views of health professionals (nursing staff) in relation to medication administration rounds and deviations from prescriptions. We will contact you separately about that in due course. For now, this information letter relates to observation of medication administration rounds.

This study has come about because although an audit of 'blank boxes' was conducted recently, there is still room to investigate all practices associated with medication administration rounds. There is currently no formal measure of medication administration practices across the Trust using objective outcome measures.

Therefore the principle aim of this study is to audit medication administration practices. The study is not about apportioning blame to any individual who deviates from normal practice but about establishing an understanding of practices and how we can learn from these findings. This study will form the basis of me Mr Hesham Abduldaeem. I am studying under the supervision of pharmacists Dr Parastou Donyai at the School of Pharmacy, University of Reading.

Why have you been invited?

You are being invited to take part in the project because we would like to observe a series of medication administration rounds on every ward at the Trust. We are hoping to observe at least 2 medication rounds per working day for a 5-day period. If you are reading this as a nurse, it is likely that your ward manager has identified you as someone who will be taking a lead in medication administration during my study period.

Do you have to take part?
It is up to you to decide to join the study. I can arrange to meet with you in order to describe the study further and go through this information sheet if necessary. If you agree to take part, I will then ask you to sign a consent form before I observe your round. You are free to withdraw at any time, without giving a reason. A copy of this information sheet and a signed consent form will be given to you to keep.

What will happen to you if you take part?
Before starting your involvement in the study you will be asked to sign a consent form. If you agree to participate in observation of your medication administration rounds, I (the researcher) will shadow you from when you start the round; I will make notes relating to which medicines have been prescribed for each patient and which medicines have been administered by you. You don't need to do anything different to your normal practice, other than allow me to observe what you normally do during a medication round. If I think that you might be about to make a minor error when you administer the medication, then I will make a note of this (keeping your identity anonymous) and we will collate such examples to provide feedback on areas of practice that can be improved at the end of the study. In practice, it would be very difficult for anyone to judge an error as having no potential for harm. If I think you are about to make an error (or are about to make an error) that I judge as being potentially harmful to the patient, then I will ask for you to read out the prescribed medication to me for our clarity (e.g. drug name and dose) and then if I still think that a potentially harmful administration error is about to be made, then I will ask to speak with you privately away from the patient to seek further clarity and alert you to the situation that there might be a potential for an error being made that could harm the patient. If we agree about this, then it would then be up to you to report the error or near-miss (depending on the situation) using your standard ward reporting systems. The pharmacist Mrs Kate Masters can be contacted in any cases where these is ambiguity.

Expenses and payments
I will not be in a position to offer any payment for observing your ward rounds for ethical reasons since this is a normal part of your job.

What will you have to do?
If you are interested in participating in this study by being observed, please tell your ward manager. I will liaise with the ward manager to schedule specific medication administration rounds to observe during my data collection weeks.

What are the possible disadvantages and risks of taking part?
This study is designed with minimal potential risks to all participants. During the observation of your medication administration rounds, I will note down any errors observed. If I judge these to be of no impact to patients, then I will not interfere with your normal practice. Instead I will collate details of all errors and then provide general feedback in relation to

areas that can be improved once the study is complete. However, if I observe an error or a potential error that I judge to have the potential to harm, or if I am not sure, then I will ask to speak with you privately, away from the patient, so that we can avoid any risk to patients. It would then be your professional responsibility to either seek further information about the reporting of the error or near-miss from your line manager, or Mrs Kate Masters (BHFT pharmacist involve in this study) or to go ahead and report the incident using the normal ward processes.

What are the possible benefits of taking part?
I cannot promise the study will help you in any specific way but you may find participating and reflecting on the topic helpful to your own practice and of course the information we get from this study might help improve the care of patients at the Trust. This is because we will identify and quantify medication administration practices and variations, which we will report back to the Trust.

What if there is a problem?
Any complaint about the way you have been dealt with during the study or any possible harm you might suffer will be addressed. How to deal with this is given in Part2.

Will my taking part in the study be kept confidential?
Yes. We will follow ethical and legal practice and all information about you will be handled in confidence. The details are included in Part 2.

If you are considering participation, please read the additional information in Part 2 before making any decision.

Part 2 of the information sheet

What will happen if you don't carry on with the study?
If you do not wish to carry on with this study, for example you wish to pull out of the observation having arranged it in advance you can withdraw at any time without giving a reason. In order to withdraw from the study, please contact me (Hesham) in the first place or otherwise please contact my supervisor whose contact details appear at the head of this letter.

What if there is a problem?
If you have any complaints about the way you have been dealt with during the study, this can be addressed by contacting my research supervisor by email or by phone. For contact details, please see the header of this Information Sheet.

Will my taking part in the study be kept confidential?
Confidentiality will be ensured for all participants, and all data collected from the observations will be used only for scientific research purposes. Observations of medication administration rounds will be recorded on paper in an anonymised fashion so that your name is not specifically identifiable. All information will be anonymised to prevent association of participants to defined observations – non-identifiable codes will be used and other identifiable information will be altered. This is critical to ensure your anonymity and confidentiality throughout the write up of the results. You might want to see the outcome of the observation of your own specific medication administration rounds but as we will be anonymising these so it will not be possible to give you any specific feedback.

What will happen to the result of the study?

The results of the study will be used in my PhD thesis. The outcomes may be presented at academic and professional conferences and in academic journals. The detail of all participants will be kept confidential and you will not be identifiable from any research paper or other publications. The data relating to observations will also be destroyed when the research is complete.

Who is organising and funding the research?
This study is being conducted with the University of Reading acting as the academic institution for my PhD. In addition, my research is supported by a full-time scholarship provided by the Saudi Government.

Who has reviewed the study?
This study has been reviewed by the University of Reading Research Ethics Committee.

Thank you for taking the trouble to read about my study

Mr Hesham Abduldaeem

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Letter of information for consent to participate in interviews

Title of Study: An audit of medication administration rounds at Berkshire Healthcare NHS Foundation Trust – gathering nurses' views

Invitation

I would like to invite you to take part in a research study. Before you decide I would like you to understand why the research is being carried out and what it would involve. If you need any clarification after reading this Information Sheet, I can arrange to meet and go through the information sheet with you in order to answer any questions you have – please see the header of this Information Sheet for my contact details. I expect that this information sheet should take about 5 to 10 minutes to read through.

Part 1 tells you the purpose of this study and what will happen if you take part.

Part 2 gives you more detailed information about the conduct of the study.

Please feel free to contact me if there is anything that is not clear.

Part 1 of the information sheet

What is the purpose of the study?
I have been conducting an audit of medication administration rounds across all wards at BHFT and last year took part in a series of observations. My purpose is to establish practices against national standards. This letter relates to interviews I hope to conduct following the observations.

I would like to explore the views of nurses in relation to medication administration rounds and deviations from prescriptions.

Although I am still writing up my report of the observations, I did find some examples relating to missed doses, blank boxes, etc which I would like to explore with nurses who complete medication administration rounds. The views and opinions of nursing staff across the wards at BHFT have not been formally collected but it is important that my quantitative study explores these views as part of my PhD.

Therefore the principle aim of this element of my study is to seek the opinions of nurses about the potential errors which I observed. The study is not about apportioning blame to any individual who deviates from normal practice but about establishing an understanding of practices and how we can learn from these findings. This study will form the basis of my (Mr Hesham Abduldaeem's) PhD. I am studying under the supervision of pharmacists Dr Parastou Donyai at the School of Pharmacy, University of Reading.

Why have you been invited?

You are being invited to take part in the project because I would like to interview nurses who are working at BHFT. In total I will aim to interview a minimum of 10 nurses to obtain a broad range of possible perceptions towards medication administration rounds and practice variations. Ideally I would like to interview one nurse form each ward.

Do you have to take part?
It is up to you to decide to join the study. I can arrange to meet with you in order to describe the study further and go through this information sheet if necessary. If you agree to take part, I will then ask you to sign a consent form before I interview you. You are free to withdraw at any time, without giving a reason. In order to withdraw from the study, please contact me (Hesham) in the first place or otherwise please contact my supervisor whose contact details appear at the head of this letter. A copy of this information sheet and a signed consent form will be given to you to keep.

What will happen to you if you take part?
Before starting your involvement in the study you will be asked to sign a consent form. If you decide to take part, I will arrange to conduct a single interview with you at your place of work at a convenient date and time to you – I hope you would be able to help me find a private space for the interview to take place. This interview is expected to last about 30 minutes but could take longer depending on your availability and interest in the work. There will be no further obligation on your part. With your permission, the interview will be audio-recorded to make sure I obtain an accurate account of the discussions.

Expenses and payments
I will be able to compensate for your time by offering a £10 Amazon voucher for the interview. In order to do that, I would obtain your email address and arrange for an electronic voucher to be sent to you after the interview.

What will you have to do?
If you are interested in participating in this study by being interviewed, please contact me by e-mail h.a.a.abduldaeem@pgr.reading.ac.uk. On receiving your email, I will contact you to arrange **one** face-to-face semi-structured interview with you at your workplace at a time and date convenient to you. The interview will be based on an interview schedule related to the medication administration observations which I have completed.

What are the possible disadvantages and risks of taking part?
This study is designed with minimal potential risks to all participants. I will aim not to ask you about any personal or sensitive issues and will avoid unnecessary intrusion. You have a right to not answer any questions that may result in some form of unease. In the unlikely event that you get upset during the interview or topics arise that cause you distress, I will stop the interview or give you the chance to talk freely, as you wish. The contact details of my supervisor are provided at the top of this sheet and they will be available to talk to you if you require additional support.

What are the possible benefits of taking part?
I cannot promise the study will help you in any specific way but you may find participating and reflecting on the topic helpful to your own practice and of course the information we get from this study might help improve the care of patients at the Trust.

What if there is a problem?
Any complaint about the way you have been dealt with during the study or any possible harm you might suffer will be addressed. How to deal with this is given in Part2.

Will my taking part in the study be kept confidential?
Yes. We will follow ethical and legal practice and all information about you will be handled in confidence. The details are included in Part 2.

If you are considering participation, please read the additional information in Part 2 before making any decision.

Part 2 of the information sheet

What will happen if you don't carry on with the study?
If you do not wish to carry on with this study, for example you wish to pull out of the interview having arranged it in advance you can withdraw at any time without giving a reason.

What if there is a problem?
If you have any complaints about the way you have been dealt with during the study, this can be addressed by contacting my research supervisors by email or by phone. For contact details, please see the header of this Information Sheet.

Will my taking part in the study be kept confidential?
Confidentiality will be ensured for all participants, and all data collected from the interviews will be used only for scientific research purposes. Interviews will be recorded with your permission using a digital audio-recorder. For the interviews, all recordings made will be removed from the audio-recorder and transferred to a secure memory stick as soon as possible. This memory stick will then be stored in a locked filing cabinet in a secure office. The recordings will then be transcribed into a word document and no names or any other details that might identify the participant will be included in the transcripts. All information will be anonymised to prevent association of participants to defined quotations – non-identifiable codes will be used and other identifiable information will be altered. This is critical to ensure your anonymity and confidentiality throughout the write up of the results. If requested, you will be given the access to the transcript of your own interview, and you will have the opportunity to review this before it is finalised and used in the research. At the conclusion of the study the digital recordings will be completely deleted.

What will happen to the result of the study?
The results of the study will be used in my PhD thesis. The outcomes may be presented at academic and professional conferences and in academic journals. The detail of all participants will be kept confidential and you will not be identifiable from any research paper or other publications. The transcript from your interview will be destroyed when the research is completed. The confidential data relating to observations will also be destroyed when the research is complete.

Who is organising and funding the research?
This study is being conducted with the University of Reading acting as the academic institution for my PhD. In addition, my research is supported by a full-time scholarship provided by the Saudi Government.

Who has reviewed the study?
This study has been reviewed by the University of Reading Research Ethics Committee.

Thank you for taking the trouble to read about my study

Mr Hesham Abduldaeem

Doctoral student
Reading School of Pharmacy
Food Biosciences building
Whiteknights, PO Box 226
Reading RG6 6AP
h.a.a.abduldaeem@pgr.reading.ac.uk

Expression of Interest

Please e-mail me (h.a.a.abduldaeem@pgr.reading.ac.uk) to confirm your interest in being interviewed.

To: Mr. Hesham Abduldaeem

I am interested to take part in your study titled: **An audit of medication administration rounds at Berkshire Healthcare NHS Foundation Trust**

Name: ----------

Contact telephone No: ----------

E-mail: ----------

Appendix 9 Consent form for observations and interviews

University of Reading

Doctoral student
Mr Hesham Abduldaeem BSc, MSc
h.a.a.abduldaeem@student.reading.ac.uk

Lecturer, Pharmacy Practice
Dr Nilesh Patel PHD, BPharm, PGCAP, MRPharmS, FHEA
+44 (0)118 378 4639
Nilesh.Patel@reading.ac.uk

Associate Professor, Pharmacy Practice
Dr Parastou Donyai MRPharmS, PhD, BPharm(Hons), PGDPRM, PGCert LTHE
+44 (0)118 378 4704
p.donyai@reading.ac.uk

Reading School of Pharmacy
Food Biosciences building
Whiteknights, PO Box 226
Reading RG6 6AP
UK

phone +44 (0)118 378 4637
fax +44 (0)118 378 4703
email pharmacy@reading.ac.uk

Consent form for observations

Title of Project: An audit of medication administration rounds at Berkshire Healthcare NHS Foundation Trust using observational methods

Name of Researcher: Hesham Abduldaeem

I have read the accompanying Information Sheet relating to the project entitled above and it has been explained to me by the researcher

The purposes of the project and what will be required of me have been discussed with me, and any questions I had have been answered to my satisfaction. I agree to the arrangements described in the Information Sheet in so far as they relate to my participation.

1. I confirm that I have read and understood the information sheet for the study. I have had the opportunity to consider the information, ask questions and these have been answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason. ☐

3. I understand that my participation in this element of the study involves being observed by a researcher from the University of Reading who will shadow me on my medication administration round. I give my permission to the researcher to make observations and to alert me to any serious error before it takes place if this is identified by them. ☐

4 Nonetheless, I understand that I feel uncomfortable in any way during the observation of my medication administration round, I have the right to end the observation. ☐

5. I understand that this project has been subject to ethical review, according to the procedures specified by the University Research Ethics Committee, and approval has been granted. ☐

6. I understand that my confidentiality as a participant in this study will remain secure and that the notes relating to my medication administration round will not contain my name. ☐

7. I have been given a copy of this consent form and the accompanying information letter. ☐

8. I would like to receive a summary of the results once the study is complete and the data analysed. For that purpose alone I give my contact details below:

_____

_____

_____

_____

9. I agree to take part in the above study.

Name……

Signed…….

Date……..

Witnessed by

Name……..

Signature……

Date……

Doctoral student
Mr Hesham Abduldaeem BSc, MSc
h.a.a.abduldaeem@student.reading.ac.uk

Lecturer, Pharmacy Practice
Dr Nilesh Patel PHD, BPharm, PGCAP, MRPharmS, FHEA
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Associate Professor, Pharmacy Practice
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UK

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fax +44 (0)118 378 4703
email pharmacy@reading.ac.uk

Consent form for interviews

Title of Project: An audit of medication administration rounds at Berkshire Healthcare NHS Foundation Trust – gathering nurses' views

Name of Researcher: Hesham Abduldaeem

I have read the accompanying Information Sheet relating to the project entitled above and it has been explained to me by the researcher

The purposes of the project and what will be required of me have been discussed with me and any questions I had have been answered to my satisfaction. I agree to the arrangements described in the Information Sheet in so far as they relate to my participation.

1. I confirm that I have read and understand the information sheet for the study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason. ☐

3. I understand that while most interviewees will find the discussion interesting and thought-provoking, if nonetheless I feel uncomfortable in any way during the interview session, I have the right to decline to answer any question or to end the interview. ☐

4. I understand that my participation in this study involves being interviewed by a researcher from University of Reading and the interview will last approximately 30 minutes and will be audio-recorded. I give my permission to the researcher to audio-record the interview by using a digital voice recorder. ☐

5. This project has been subject to ethical review, according to the procedures specified by the University Research Ethics Committee, and approval has been granted ☐

6. I understand that my confidentiality as a participant in this study will remain secure and that the transcript of my interview will not contain my name. ☐

7. I have been given a copy of this consent form and the accompanying information letter. ☐

8. I wish to receive a summary of the results once the study is complete and the data analysed, for that purpose alone I give my contact details below: ☐

_____

_____

_____

_____

9. I agree to take part in the above study.

Name……

Signed…….

Date……..

Witnessed by

Name……..

Signature……

Date……

Appendix 10 Ward managers letter

University of Reading

Associate Professor, Pharmacy Practice
DR PARASTOU DONYAI PHD BPHARM, BSC (HONS) PSYCH (OPEN) PGDPRM(OPEN) PGCERT LTHE PGCERT EBM
+44 (0)118 378 4704
p.donyai@reading.ac.uk

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Food BioScience Building
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fax +44 (0)118 4708
email pharmacy@reading.ac.uk

Dear all,

An audit of medication administration rounds at BHFT

I am writing to ask for your help. You might recall that some time back my PhD student Mr Hesham Abduldaeem attended a ward managers' meeting to describe his project focussing on medication administration rounds. I am writing to coordinate the visits.

In essence, Hesham will be observing medication administration by shadowing the nurses and making notes discretely. This is likely to be a sensitive issue but Helen Mackenzie, Director of Nursing and Governance at the Trust is supportive of the work and we understand that observing care on wards is already an important part of CQC inspections. We hope that the information letter enclosed provides assurance as to the purpose and nature of the visits. The study has received approval from the University of Reading Research Ethics Committee. The Trust Clinical Audit department has also approved the study and a copy of the approval letter is also enclosed with this pack.

Hesham will visit every ward at the Trust on 4 different days and on each visit he will observe one or two medication administration rounds (e.g. morning and/or lunchtime). He will arrive around 2 hours before the first round to examine the drug charts and the medication cabinets for familiarisation. The enclosed poster can be placed somewhere visible on the ward to explain his presence on the day. We hope that you will be able to support this study by:

- Discussing the study and encouraging your nursing staff to participate using the letter of information and consent form enclosed
- Examining the proposed visit days (enclosed as a separate table herewith) to check that these don't clash with any other events
- Communicating the above information to nurses on duty during the visits

I would be grateful if you could please contact me **as soon as possible** if any of the days proposed will cause difficulty for your ward. I can be contacted either via email p.donyai@reading.ac.uk or by telephone 0118 378 4704. In the event that I don't hear back from you in the next few weeks, Hesham will telephone you to offer an opportunity to discuss the project in more detail if needed and to confirm the dates with you if we have not heard back from you. Thank you and please contact me if you require any further information.

Yours sincerely,
Dr Parastou Donyai PhD, Director of Pharmacy Practice, University of Reading

University of Reading

Associate Professor, Pharmacy Practice
DR PARASTOU DONYAI PHD BPHARM, BSC (HONS) PSYCH (OPEN) PGDPRM(OPEN) PGCERT LTHE PGCERT EBM
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phone +44 (0)118 4637
fax +44 (0)118 4703
email pharmacy@reading.ac.uk

Dear all,

An audit of medication administration rounds at BHFT

I am writing to ask for your help. You might recall that some time back my PhD student Mr Hesham Abduldaeem attended a ward managers' meeting to describe his project focussing on medication administration rounds. I am writing to coordinate the visits.

As you know, Hesham was observing medication administration round by shadowing the nurses and making notes discretely. This is likely to be a sensitive issue but Helen Mackenzie, Director of Nursing and Governance at the Trust was supportive of the work and we understand that observing care on wards is already an important part of CQC inspections. Hesham want to complete the study by interviewing some nurses to gain there opinion about the medication administration errors that he found and about the practice. We hope that the information letter enclosed provides assurance as to the purpose and nature of the interviews. The study has received approval from the University of Reading Research Ethics Committee. The Trust Clinical Audit department has also approved the study and a copy of the approval letter is also enclosed with this pack.

Hesham will interview 19 nurses (10 from psychiatric wards and 9 from community hospital wards). The interview will take between 20-30 minutes. And the participant will have amazon voucher at the end of interview. He will arrive around 1/2 hour before the interview. We hope that you will be able to support this study by:

- Discussing the study and encouraging your nursing staff to participate using the letter of information and consent form enclosed

I would be grateful if you could please contact me **as soon as possible** if any of the days proposed will cause difficulty for your ward. I can be contacted either via email p.donyai@reading.ac.uk or by telephone 0118 378 4704. In the event that I don't hear back from you in the next few weeks, Hesham will telephone you to offer an opportunity to discuss the project in more detail if needed and to confirm the dates with you if we have not heard back from you. Thank you and please contact me if you require any further information.

Yours sincerely,
Dr Parastou Donyai PhD, Director of Pharmacy Practice, University of Reading

Appendix 11 Observational note example

1. Rowan ward:

Psychiatric ward - more than 20 patients (older adults with dementia). The ward was attended around 1-2 hours earlier before starting the observation (which I did for all wards), to check the drug chart and to write each medication that will be given at this time of administration.
The drug charts as all psychiatric ward are messy (the doctors cross the order and re-order many times)
The clinic room was secured and contains one bed, two chairs, cupboard for stock drug, fridge to store the fridge items, and two non-movable trolley and cupboards to store the patient drugs and fast move medication (For male and female).
The nurse came to check the patient drug charts about 15 minutes before starting the administration (ordering the drug charts to be ready prepare the drug for the patients and administered to them in their room/place one by one). Bedside-prepared in clinic room mode of administration
The clinic room was very big and the drug chart was well-ordered. The patient medication container is organised but still (the patient name was written by hand and there is no other information e.g. medical number, age etc.). At the time of administration; the nurse checked the patient's name by asking and confirmation their name, and there was no any other identity check.
This ward was a bit difficult to deal with the patients due to elderly (dementia patients). Some patients refused to take their drugs and the nurse placed it in their meal (Covert).
(The morning 8:00 round observation the administered nurse signed first then give the drug).
(The evening 18:00 round observation the administered nurse was not checking the expiry at all).

No.	Date	Ward	Time	Day	Duration	Other activity	Staff down?	Permanent or Bank	Gender	Pt No	OE in Round	No Patients in Round	Pt Gender	Drug name	Strength	Route	Frequency	Error type	Interruption type	Comments
22	05/08/2015	Rowan	NOON	Wednesday	00:42	Lunch time	NO	Band 5	F	249	15	7	M	Gabapentin	100mg	Oral	TDS	U3	0	Blank box (pt. not at room)

The nurse obtained the Gabapentin from the cupboard. This is because the patient regularly takes this medication and the supply stored in clinic room. However, I noticed that the patient was not at the room in this time and the nurse decided to give the drug to patient later before the end of the round and left the box blank. I was waiting until the round finished but the nurse still forgot to give this drug to the patient.

Comment [HAAA20]: Ward was busy with more than one activity (Lunch time)

Comment [HAAA21]: Patient's regular named medication (oral) kept in the clinic room cupboard

Comment [HAAA22]: Nurse forgot to give this until end of round

No.	Date	Ward	Time	Day	Duration	Other activity	Staff down?	Permanent or Bank	Gender	Pt No	OE in Round	No Patients in Round	Pt Gender	Drug name	Strength	Route	Frequency	Error type	Interruption type	Comments
22	05/08/2015	Rowan	NOON	Wednesday	00:42	Lunch time	NO	Band 5	F	249	15	7	M	Diazepam	4mg	Oral	BD	U3	0	Blank box (pt. not at room)

The nurse obtained the Diazepam from the cupboard. This is because the patient regularly takes this medication and the supply stored in clinic room. However, I noticed that the patient was not at the room in this time and the nurse decided to give the drug to patient later before the end of the round and left the box blank. I was waiting until the round finished but the nurse still forgot to give this drug to the patient.

Comment [HAAA23]: Ward was busy with more than one activity (Lunch time)

Comment [HAAA24]: Patient's regular named medication (oral) kept in the clinic room cupboard

Comment [HAAA25]: Nurse forgot to give this until end of round

No.	Date	Ward	Time	Day	Duration	Other activity	Staff down?	Permanent or Bank	Gender	Pt No	OE in Round	No Patients in Round	Pt Gender	Drug name	Strength	Route	Frequency	Error type	Interruption type	Comments
22	05/08/2015	Rowan	NOON	Wednesday	00:42	Lunch time	NO	Band 5	F	249	15	7	M	Paracetamol	1gm	Oral	QDS	U3	0	Blank box (pt. not at room)

The nurse obtained the Paracetamol from the cupboard. This is because the patient regularly takes this medication and the supply stored in clinic room. However, I noticed that the patient was not at the room in this time and the nurse decided to give the drug to patient later before the end of the round and left the box blank. I was waiting until the round finished but the nurse still forgot to give this drug to the patient

Comment [HAAA26]: Ward was busy with more than one activity (Lunch time)

Comment [HAAA27]: Patient's regular named medication (oral) kept in the clinic room cupboard

Comment [HAAA28]: Nurse forgot to give this until end of round

No.	Date	Ward	Time	Day	Duration	Other activity	Staff down?	Permanent or Bank	Gender	Pt No	OE in Round	No Patients in Round	Pt Gender	Drug name	Strength	Route	Frequency	Error type	Interruption type	Comments
22	05/08/2015	Rowan	NOON	Wednesday	00:42	Lunch time	NO	Band 5	F	249	15	7	M	Buspirone	5mg	Oral	TDS	U3	0	Blank box (pt. not at room)

The nurse obtained the Buspirone from the cupboard. This is because the patient regularly takes this medication and the supply stored in clinic room. However, I noticed that the patient was not at the room in this time and the nurse decided to give the drug to patient later before the end of the round and left the box blank. I was waiting until the round finished but the nurse still forgot to give this drug to the patient

Comment [HAAA29]: Ward was busy with more than one activity (Lunch time)

Comment [HAAA30]: Patient's regular named medication (oral) kept in the clinic room cupboard

Comment [HAAA31]: Nurse forgot to

Appendix 12 Observational and interviews analysis example

1. Observation notes

Ward	Mode of administration	**Expiry Error**			
		Example of notes recorded	Active failure category – i.e. slips, lapses, violation, mistake etc.	Error-producing condition	Latent condition
PW8	Bedside-prepared in clinic room	"*The nurse obtained the medication from the clinic room cupboard and gave it to the patient. This is because the patient regularly takes this medication and had their own supply stored in clinic room. When I checked to see if there was a label on the bottle to indicate when it has been opened and therefore when it might expire, I did not find this label. I think this error happens because some nurses maybe think that the medication might be used up before it expires."*	Situational violation	Staff workload	Safety culture and priorities
CHW1	Bedside-patient locker	"*The nurse obtained the medication from the patient locker and gave it to the patient. This is because the patient regularly takes this medication and had their own supply stored in the patient's locker. When I checked to see if there was a label on the bottle to indicate when it has been opened and therefore when it might expire, I did not find this label I think this error happens because some nurses maybe think that the medication might be used up before it expires."*	Situational violation	Staff workload	Safety culture and priorities
CHW5	Bedside-trolley	"*The nurse obtained the medication from the trolley and gave it to the patient. This is because the patient regularly takes this medication and had their own supply stored in the trolley. When I checked to see if there was a label on the bottle to indicate when it has been opened and therefore when it might expire, I did not find this label. I think this error happens because some nurses noted expiry while I was on ward."*	Situational violation	Staff workload	Safety culture and priorities

2. Nurses' interview

Interview	**Expiry Error**			
	Quote	Active failure category – i.e. slips, lapses, violation, mistake etc.	Error-producing condition	Latent condition
CN1	"*It's not by mistake, I think when, it's not, maybe not, everybody not aware of that you need to write the date in there, that one because usually the pharmacist asking that when did it open. Not maybe everybody remember to write that one. That, I think that one, it was, it's probably Gaviscon bottle, it's a full big bottle, when you're opening that one you asking, patient is asking for ten ml Gaviscon, you're getting that one and giving it straight to the patients and you're not staying there to write the date and time on there at the time so then you forget. That's what happens*." "*This is just not remembering, not aware it is necessary to do these things because there its valid date is from 28 days and they know that, but they don't remember or they don't think that they need to write that date in there*."	Lapse – omission Knowledge-based mistake	Staff workload Lack of knowledge	Safety culture and priorities
PN1	"*Yeah, I guess it's whoever's opened its responsibility to do that. I guess, just forgetting I suppose. Perhaps maybe not a good enough knowledge about what kind of medications need, I think most people would know the eye drops need to be 28 days. But I think a lot of the topical, like the creams and stuff, I think people could perhaps just not realise that that needs to be done. Yeah*." [In relation to insulin] "*Yeah. Well, people should know that. But, yeah, no. I think just forgetting possibly*." "*I think that's not talked about often enough, about those little things like expiry dates and writing when things have been opened. I think that's not talked about enough, so it's not pressed in to people's minds that that's something you need to be doing on a regular basis, whenever you open anything new. I think we don't, probably don't discuss that enough in terms of medicines management*."	Lapse – omission Knowledge-based mistake Lapse – omission	Lack of knowledge	Safety culture and priorities
PN2	"*We just forget. We just get the medications and open it to dispense it. I don't know. I think, yeah, just generally you just go to the cupboard, you open it up, you dispense. Yeah, I suppose you just, some people just forget*."	Lapse – omission	Staff workload	Safety culture and priorities

3. Pharmacists interview

Interview	Expiry Error			
	Quote	Active failure category – i.e. slips, lapses, violation, mistake etc.	Error-producing condition	Latent condition
PH3	*Because I don't think the nurses are familiar with the process, they're not familiar about putting the expiry date on when they're opening up liquid medicines; they're not familiar at all. So they're not aware of it, I would say, yeah* *Yeah, so the nurses should be, need to be educated, this needs to be reinforced, from training to making sure that they are aware, that they know about this, yeah.*	Knowledge-based mistake	Lack of knowledge	Safety culture and priorities
PH4	*They don't know that they've got to do it for that medicine. Because it's not for every medicine they don't know which ones they do have to do it to and they don't remember to do it. you can train them to get it better, you can improve things but it's constant, constant training and constant nagging but you need to put tools in place to support them to know, insulin, write the date on it so put a label on the shelf when they get it out the fridge to write the date on it. You actually have to put visual reminders to remind people to do it because they won't remember because they have thousands of other bits of information to remember and trying to remember everything is impossible so you have to put processes in place to, and reminders, visual reminders for people to remember that's the drug you've got to put the opening date on.* *I think you need posters, training sessions, reminders, but something has to be at the product level where the nurses are using it to remind them to do it. So, you would have a blank sticker on it that says, date opened, expiry date, which they then fill in because it's a visual reminder on the packet for them to do it. And that's labour intensive to do because it doesn't come from the manufacturer, not always, but, and you have to put posters up, maybe labels on the shelf where they get it out of the cupboard, saying reminder, put the dates on for these products. And if it's constantly there in multiple places you might then improve it. But if you leave it, if you don't do those sorts of things you're never going to, a nurse is never going to remember which products need it and which ones don't.*	Knowledge-based mistake Lapse – omission	Lack of knowledge Staff workload	Safety culture and priorities

Appendix 13 Tables of other quantitative results

Table 1: The medication involved in MAEs across all wards including whether these in critical list medications or not

Main medication	MAEs	Critical list
Clonazepam	4	No
Codeine phosphate	4	No
Ensure	7	No
Flucloxacillin	4	No
Heparin	4	Yes
Quetiapine EC	4	No
Sodium valproate 200mg/5ml	4	No
Trazodone 50mg/5ml	4	No
Viscotears	4	No
Vitamin B compound	4	No
Gaviscon	5	No
Senna	5	No
Omeprazole	5	No
Insulin	14	Yes
Salbutamol	6	No
Laxido/Movicol sachet	8	No
Diprobase cream	12	No
Aspirin	14	No
Paracetamol	22	No
Beclometasone	17	No
Procal shot	28	No
Lactulose 10g/15ml	24	No

Table 2: The number MAEs on route of administration observed

Route of administration	No. of MAEs
Ear Drop	2
Eye Drop	25
Eye Ointment	2
Inhaler	31
Intramuscular	1
Mouth Wash	1
Nasal Spray	2
Nebuliser	1
Oral	247
Rectal	1
Subcutaneous	19
Topical	35

Table 3: the types of potential harm that were found

Types of potential harm	Explanation of potential harm
No date and time of administration in drug chart	1- Patient could get over dose
Was attempting to give at wrong time	
Was attempting to give high dose	
Given but Blank box	
Was attempting to give two medications contain same generic ingredient	
Was attempting to give low dose	2- Patient might not get enough dose
Missed dose	3- Patient might have complication of not taking the medication
No opening and expiry date of eye drop	4- Patient might have complication from bacteria
Did not dissolve aspirin	5- Patient might has drug irritation

Appendix 14 Publications and presentations related to this thesis

Published Abstracts

Abduldaeem, H., Masters, K., Patel, N. & Donyai P. 2016. A direct observation study of medication administration errors in a mental health inpatient setting. International Journal of Pharmacy Practice, 1, 4–29.

Abduldaeem, H., Donyai P. & Patel, N. 2016. Using the Observational Method to Capture Medication Administration Practices: Errors and Contributing Factors. 9th Saudi Student Conference in UK.

Oral Presentations

A direct observation study of medication administration errors in a mental health inpatient setting, HSRPP Conference, 7th - 8th April 2016, Reading, UK.

Medication Administration Errors in Psychiatric and Community Hospital Wards: A Direct observation method, Pharmacy Practice Research Showcase, 14th April 2016, Reading, UK.

Appendix 15 Reading Researcher Development Programme RRDP

Scientific Writing Lecture	**Dr. Bakhle**	**26th Nov 2013 12pm**
Academic Writing Skills for Non-native Speakers	Dr. Sarah Brewer	15th January 2014 11:00 – 13:00
Basic Statistics Refresher	Member of the Statistical Services Centre	28th January 2014 14:00 – 17:30
Quality Data for Good Research	Member of the Statistical Services Centre	4th February 2014 09:00 – 17:00
Managing your research project	Dr. Andrew Charlton-Perez	19th February 2014 10:00 – 12:00
Sourcing Information for a Literature Review – information retrieval	Melvin Morbey	25th February 2014 11:00 – 13:00
Preparing posters - Theory (Part 1) & Practical (Part 2) - one day session	Laura Bennetto	10th March 2014 11:00 – 16:00
How to write a thesis	Dr. Anna Macready	27th January 2015 14:00-16:00
Academic writing skills for non-native speakers - workshop	Dr. Sarah Brewer	2nd March 2015 14:00-16:00
Writing up your data analysis		4th March 2015 14:00-17:30
Understanding and using images: theory and practice	Laura Bennetto	24th March 2015 14:00-16:00
Doctoral research conference		18th June 2015
How to write a paper		27th Jan 2016
How to get published		23rd Feb 2016
Self-management: Managing academic pressure		10th May 2016
Doing Thematic Analysis workshop	Dr. Cath Sullivan	5th July 2016
Qualitative interviewing: Individual interview, Focus group and Beyond	Prof. Adrian Coyle	6th July 2016