Types and contributing factors of dispensing errors in hospital pharmacies

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Declaration

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

Signed:

December, 2015

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List of abbreviations

ADEs	Adverse Drug Events
ADRs	Adverse Drug Reactions
APSF	Anesthesia Patient Safety Foundation
CCGs	Clinical Commissioning Groups
CPOE	Computerized Physician Order Entry
DPIC	Drug and Poison Information Centre
GPhC	General Pharmaceutical Council
GP	General Practitioner
ISMP	Institute for Safe Medication Practices
IOM	Institute of Medicine
SKMC	King Saud medical City
KSA	Kingdom of Saudi Arabia
L&D	Luton and Dunstable University Hospital NHS Foundation Trust
Mpharm	Master of Pharmacy
MRPs	Medicine related problems
NCCMERP	National Coordinating Council for Medication Error Reporting and Prevention
NPSA	National Patient Safety Agency
NRLS	National Reporting and Learning System
P.O.S	Policy Operative System
PCTs	Primary Care Trusts
RCA	Root Cause Analysis
SCFHS	Saudi Commission for Health Specialties
SHAs	Strategic Health Authorities
UK	United Kingdom
USA	United States of America
WHO	World Health Organization

Abstract

Background: Dispensing medication is a chain of multiple stages, and any error during the dispensing process may cause potential or actual risk for the patient. Few research studies have investigated the nature and contributory factors associated with dispensing errors in hospital pharmacies.

Aim: To determine the nature and severity of dispensing errors reported in the hospital pharmacies at King Saud Medical City (KSMC) hospital in Saudi Arabia, and at Luton and Dunstable University Hospital (L&D) NHS Foundation Trust in the UK; and to explore the pharmacy staff perceptions of contributory factors to dispensing errors and strategies to reduce these errors.

Materials and Methods: A mixed method approach was used and encompassed two phases. Phase I: A retrospective review of dispensing error reports for an 18-month period at the two hospitals. The potential clinical significance of unprevented dispensing errors was assessed. Data was analysed using descriptive statistics in SPSS and A Fisher's test was used to compare the findings. Phase II: Self-administered qualitative questionnaires (open-ended questions) were distributed to the dispensary teams in KSMC and L&D hospitals. Content analysis was applied to the qualitative data using NVivo qualitative analysis software.

Result: Dispensing the wrong medicine or the incorrect strength were the most common dispensing error types in both hospitals. Labelling errors were also common at the L&D pharmacy dispensary. The majority of the unprevented dispensing errors were assessed to have minor or moderate potential harm to patients. Look-alike/sound-alike medicines, high workload, lack of staff experience, fatigue and loss of concentration during work, hurrying through tasks and distraction in the dispensary were the most common contributory factors suggested. Ambiguity of the prescriptions was a specified factor in the L&D pharmacy, while poor pharmacy design and unstructured dispensing process were specified contributory factors in the KSMC pharmacy.

Conclusions: Decreasing distractions and enhancing the pharmacy design and the dispensing workflow are necessary to reduce dispensing errors. Furthermore, monitoring and reporting errors and educating the dispensary team about these errors is also needed. Automation and e-prescribing systems may improve dispensing efficiency and safety. The findings of this study reemphasise the fact that dispensing errors are prevalent in hospital pharmacies. Efficient interventions need to be implemented to mitigate these errors.

Chapter 1: Introduction

1.1 Patient safety

Currently, one of the main goals of all healthcare institutions and healthcare providers is to improve patient safety. The simplest definition of patient safety is *"the prevention of errors and adverse effects to patients associated with health care"* (WHO, 2015). In some countries, patient safety incidents have been receiving greater attention from healthcare providers and institutions, and they are becoming recognised as a global problem. For example, the World Health Organization (WHO) reported that 1 out of 10 patients is harmed while receiving healthcare in hospitals in developed countries (WHO, 2014). The National Patient Safety Agency recorded over 1.3 million patient safety incidents in England and Wales for the period between October 2010 and September 2012, and these incidents cost the NHS around £2 billion a year (Government-Knowledge, 2012). About 1.5 million patient safety incidents that occurred annually in United States of America (USA) can be prevented (Aspden et al., 2006).

Patient safety as a concept has been recognised since the time of Greek healers in the fourth century BC. They drafted the Hippocratic Oath, “I will do no harm", which recognised the potential for injuries that arise from the well-intentioned actions of healers (Adhikari, 2010, Tyson, 2001, Ehrmeyer and Laessig, 2008). The first medical initiative to champion patient safety as a specific focus was the Anesthesia Patient Safety Foundation (APSF) in the USA, which was established in 1985 to reduce the mortality and morbidity rate associated with anaesthesia; there was a common impression that anaesthesia care itself caused significant mortality (APSF, 2010).

In 1999, the Institute of Medicine (IOM) released a report called “*To Err Is Human: Building a Safer Health System”*. The report estimated that between 44,000 and 98,000 people in the USA die annually as a result of patient safety incidents that can be prevented, and these incidents cost between $17 billion and $29 billion (Kohn et al., 1999, Brennan et al., 1991, Thomas et al., 2000). However, patient safety gained more

attention after the publication of the IOM report, which became a landmark publication in patient safety (Ulrich and Kear, 2014, Clancy, 2009, Wischet and Schusterschitz, 2009, Knaus, 2002, Han et al., 2005).

In the UK, the Department of Health launched *"An Organisation with a Memory"* report which mirrored the approach of *"To Err is Human*" (Department of Health, 2000). In this report, the Chief Medical Officer reported that patient safety incidents occurred in around 10% of National Health Service (NHS) hospital patients (850,000) every year, costing the NHS around £2 billion. The report pointed out that the practice of reporting and learning from the errors was not developed enough in the UK (Department of Health, 2000). The *"An Organisation with a Memory"* report led to the initiation of studies to quantify the incidence of harm and qualitative research to identify the failure mechanisms that result in patient harm (Fisher et al., 2015). Since "An Organisation with a Memory" was published, important and necessary steps have been taken on the journey to improve patient safety across the NHS. Building a safer NHS for patients was launched on 2001 and describes the work being undertaken, and planned, to implement the recommendations contained in An Organisation with a Memory (Carruthers and Philip, 2006). One recommendation was to encourage local and national reporting systems for adverse events and errors, which would be implemented and operated by a new independent body, the National Patient Safety Agency (NPSA), which was subsequently established in same year (Department of Health, 2001). The NPSA has the responsibility of improving the patient safety and improve the quality of healthcare through reporting, analysing, and disseminating the lessons of adverse events and 'near misses' involving NHS patients (Smith, 2004).

In recent times, health care institutions and global organisations have taken the concept of patient safety very seriously, resulting in special centres for patient safety being established across the world. Examples of this initiative are the World Alliance for Patient Safety (WHO, 2009b), the National Patient Safety Foundation in the USA (NPSF, 2015) and the Canadian Patient Safety Institute (CPSI, 2015). The main function

of these organisations is to reduce medical errors by understanding the causes of errors, and then finding solutions to them (NPSF, 2015, WHO, 2009b).

These patient safety centres have contributed to improving patient safety. For instance, the World Alliance for Patient Safety, which run by the WHO, contributed to improving patient safety in several countries, through projects concerned with managing concentrated injectable medicines, assuring medication accuracy at transitions in care and performance of the correct procedure at the relevant body site (WHO, 2013). Also the WHO contributed to improving patient safety in poor countries during conducted research about in patient safety incident in these countries and assist the countries to identify and reduce national barriers and implement the patient safety strategies and programmes (WHO, 2010). In UK, the NPSA contributed to improving patient safety through building reporting systems to collect and analyse information from staff and patients (Terry et al., 2005). The NPSA has a number of tools and resources available to support the NHS organisations to understand and to make changes to their working practices and safety culture with the aim of reducing the patient safety incident (NHS, 2009).

Recent research shows that patient safety is still a widespread issue, even in developed countries. James et al. (2013) estimated that more than 210,000 patients are killed annually in USA hospitals by preventable hospital errors each year. In the UK, more than 1.6 million patient safety incidents have been reported to the National Reporting and Learning System by NHS organisations in England and Wales in 2014 (NHS, 2015a). Baker et al. (2004) conducted a retrospective research study by reviewing patient charts in Canadian hospitals. They found that about 7.5% of patients admitted to acute care in Canadian hospitals were there because of adverse events. Also, studies conducted in Dutch hospitals showed patient safety incidents are high. For instance, a study by Zegers et al. (2009) found that 5.7% of patients were admitted to hospital because of patient safety incidents; most of these incidents were preventable. In Saudi Arabia, the number of legal cases related to medical errors has increased from 896 cases in 2005 to 1,356 cases in 2008 (an increase of around 51%) (Alahmadi, 2010).

The healthcare service is one of the essential services for daily life, and it is becoming more complex, due to new technologies, medicines and treatments strategies. Designing an effective healthcare service system will help to improve patient safety (Nolan, 2000). Countries use different healthcare service systems, which may lead to different types of patient safety incidents. Healthcare services in USA are provided mainly by the private sector via health insurance (Rice et al., 2013). In France, the healthcare services are provided to legal residents via a public health insurance system (Chevreul et al., 2010). According to the WHO ranking of health systems in 2000, France has the best healthcare system in the world, while the USA healthcare system was ranked 38th out of 191 healthcare systems worldwide (WHO, 2000). The WHO rank depends on the overall level and distribution of health in the populations, and the responsiveness and financing of health care services. Patient safety is associated with the level of the healthcare system for example, approximately 330,000 deaths every year because of failures of the healthcare service, while the death rate in France is approximately half of that (Patient Safety America, 2016). This research concerns the Kingdom of Saudi Arabia (KSA) and the United Kingdom (UK), and hence there is a need to describe the healthcare systems of both in greater detail.

1.2 Healthcare Systems in the KSA and the UK

1.2.1 Healthcare System in the KSA

The healthcare system in the KSA is ranked by the WHO 26th out of 191 healthcare systems worldwide (WHO, 2000). Healthcare services in KSA are provided free of charge for Saudi citizens, and are managed through the government's Ministry of Health, which is responsible for the formulation of management policies. Additionally, other government sectors provide healthcare services for their employees, i.e. the Ministry of Defence, the Ministry of the Interior, the National Guard and the Ministry of Education (MOH, 2012). In contrast, the private sector also contributes to providing healthcare services in KSA for a fee or through private medical insurance. There are three levels of healthcare services: primary care through the primary health centres

(general practitioners), secondary care in the general hospitals and tertiary care through the specialist hospitals, such as eye hospitals and heart centres (MOH, 2012). This healthcare structure is presented in Figure 1.1.

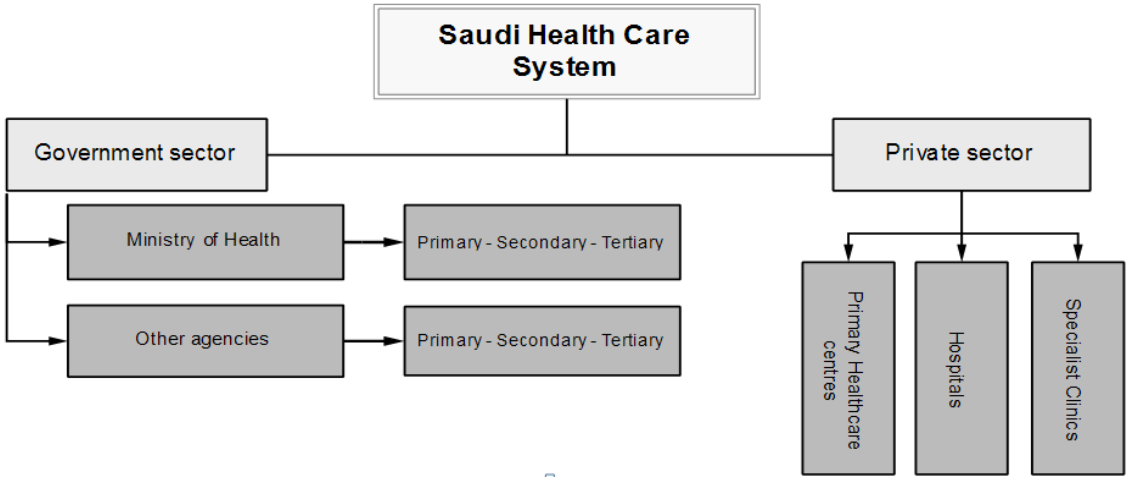

Figure 1.1: Current structure of the healthcare sectors in KSA (Almalki et al., 2011)

The Ministry of Health accounts for 60% of the healthcare provision in the KSA; this includes 251 hospitals with a total capacity of 34,459 beds and 2,109 primary care centres (MOH, 2012). These hospitals and primary care centres are distributed throughout all of the Kingdom's provinces; furthermore, all of these institutions are under the supervision of 20 regional directorates-general of health affairs in various parts of the country (Almalki et al., 2011). Other government agencies cover around 19% of the healthcare services in the Kingdom, with the total capacity of these hospitals/agencies reaching 10,948 beds (MOH, 2012). Finally, a further 130 private hospitals, with a total capacity of 13,298 beds, 2,185 private polyclinics and 198 private clinics, provide the remaining 21% of the healthcare services in the KSA (MOH, 2012). The Ministry of Health remains the ultimate responsible agency for managing and formulating the healthcare policies in the KSA, as well as for monitoring the healthcare services in the private sector (Al-Yousuf et al., 2002).

The Ministry of Health is the central government body responsible for setting and managing health policies. The main role of the Ministry is to support the government to improve the health of the population. To accomplish this, it sets overall health policies and strategies, while also managing legislation and regulations for the private sector (Albejaidi, 2010). Recently, the government established the Council of Health Services, which is headed by the Minister of Health and includes members from other government health sectors and the private sector (Almalki et al., 2011). This Council aims to develop coordination and integration among all of the healthcare service authorities in the KSA (Almalki et al., 2011).

Several challenges faced by the Saudi healthcare system include the shortage of local healthcare professionals and the lack of unified electronic national health information systems (Almalki et al., 2011). Furthermore, the Ministry of Health provides healthcare services to millions of visitors and pilgrims from across the world during the Hajj or Umrah season (Jannadi et al., 2008).

The Ministry of Health in the KSA provides medicines, free of charge, through the pharmacies in hospitals and in the primary care centres that are distributed throughout the Kingdom. The Pharmaceutical Care Department in each region's Department of Health Affairs is responsible for overseeing the pharmacies affiliated with the Ministry of Health in their region. Furthermore, the Pharmaceutical Care Department in the Ministry of Health is the responsible agency for formulating and managing the policies and procedures for all of the Ministry of Health's pharmacies. One of the department's responsibilities is to enhance patient safety during the dispensing of medicines. For instance, the Pharmaceutical Care Department has contributed to the implementation of a medication safety programme in some hospitals, and has spread information about medication safety to inform dispensary teams and other healthcare professionals about medication errors (MOH, 2015).

1.2.2 Healthcare system in the UK

The healthcare system in the UK is one of the most effective healthcare systems in the world, and it was ranked, by the World Health Organization (WHO) in 2000, in 18th place among 191 countries (WHO, 2000). Also, it was ranked by the Commonwealth Fund in 2013 as the best healthcare system compared to ten other developed countries (The Commonwealth Fund, 2014, Davis et al., 2014). The Commonwealth Fund ranked the healthcare systems in 11 developed countries by measures of health system quality, efficiency, access to care, equity, and healthy lives. Figure 1.2 shows the ranking for each measure. However, healthcare in the United Kingdom is a devolved matter, meaning that England, Northern Ireland, Scotland and Wales each have their own healthcare systems as a result of each region having different policies and priorities (NHS, 2012a). The National Health Service (NHS) was established in 1948. The objective of the NHS was to provide free healthcare for those citizens who did not have the means to pay for healthcare themselves (Webster, 2002).

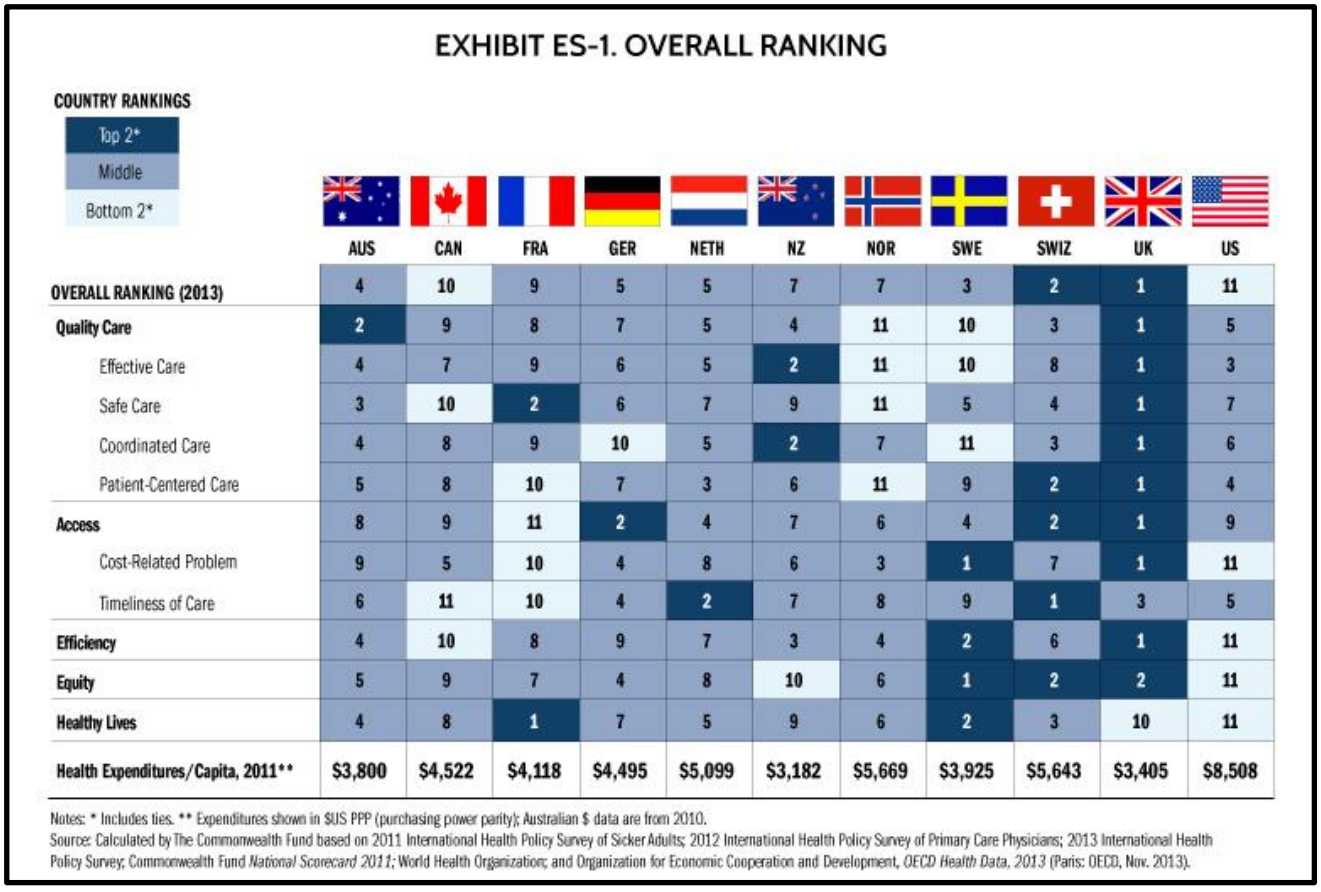

EXHIBIT ES-1. OVERALL RANKING

COUNTRY RANKINGS

Top 2*

Middle

Bottom 2*

	AUS	CAN	FRA	GER	NETH	NZ	NOR	SWE	SWIZ	UK	US
OVERALL RANKING (2013)	4	10	9	5	5	7	7	3	2	1	11
Quality Care	2	9	8	7	5	4	11	10	3	1	5
Effective Care	4	7	9	6	5	2	11	10	8	1	3
Safe Care	3	10	2	6	7	9	11	5	4	1	7
Coordinated Care	4	8	9	10	5	2	7	11	3	1	6
Patient-Centered Care	5	8	10	7	3	6	11	9	2	1	4
Access	8	9	11	2	4	7	6	4	2	1	9
Cost-Related Problem	9	5	10	4	8	6	3	1	7	1	11
Timeliness of Care	6	11	10	4	2	7	8	9	1	3	5
Efficiency	4	10	8	9	7	3	4	2	6	1	11
Equity	5	9	7	4	8	10	6	1	2	2	11
Healthy Lives	4	8	1	7	5	9	6	2	3	10	11
Health Expenditures/Capita, 2011**	$3,800	$4,522	$4,118	$4,495	$5,099	$3,182	$5,669	$3,925	$5,643	$3,405	$8,508

Notes: * Includes ties. ** Expenditures shown in $US PPP (purchasing power parity); Australian $ data are from 2010.

Source: Calculated by The Commonwealth Fund based on 2011 International Health Policy Survey of Sicker Adults; 2012 International Health Policy Survey of Primary Care Physicians; 2013 International Health Policy Survey; Commonwealth Fund *National Scorecard 2011;* World Health Organization; and Organization for Economic Cooperation and Development, *OECD Health Data, 2013* (Paris: OECD, Nov. 2013).

Figure 1.2: Healthcare ranking for some healthcare system developed countries

Currently, healthcare services are provided free to all residents in England. In contrast, about 13% of the population are covered by private medical insurance, which mainly provides access to acute elective care in the private sector (Boyle, 2011). The Department of Health (DOH) is the central government body responsible for formulating and monitoring policies for the NHS (Boyle, 2011, The Commonwealth Fund, 2010). The Department of Health used to operate at a regional level through 10 Strategic Health Authorities (SHAs). The SHAs were established in 2002 to manage the local NHS facilities and to provide healthcare services within their local areas (NPSA, 2012a). However, the SHAs were also responsible for the strategic supervision of all NHS Trusts within their geographic area; this included focusing on improving the healthcare services in their local area and ensuring that their clients are receiving high-quality care (NHS, 2012b).

Each SHA's area contained a number of NHS Trusts, which are responsible for running or commissioning the healthcare services within their local area (Boyle, 2011). However, several types of Trusts were supervised by the SHAs, for instance Primacy Care Trusts, Care Trusts, Mental Health Trusts, NHS Trusts and Ambulance Trusts (White, 2010). However, a new healthcare structure was established in April 2013; all NHS trusts are expected to become foundation trusts by 2014 (NHS, 2014a). Some organisations, such as Primary Care Trusts (PCTs) and SHAs, have been abolished and replaced with the new system of Clinical Commissioning Groups (CCGs). CCGs have taken on many of the functions of SHAs and PCTs, in addition to some other functions (NHS, 2014a, NHS, 2013). The Care Quality Commission is responsible for improve the patient safety and assessing and making judgments as to the level of safety and quality of care provided by providers of health and social care. The main aim of the new healthcare structure is to improve quality and healthcare outcomes, which is expected to lead to an increase in patient safety. The Figure 1.3 illustrates the structure of the new healthcare system in the UK.

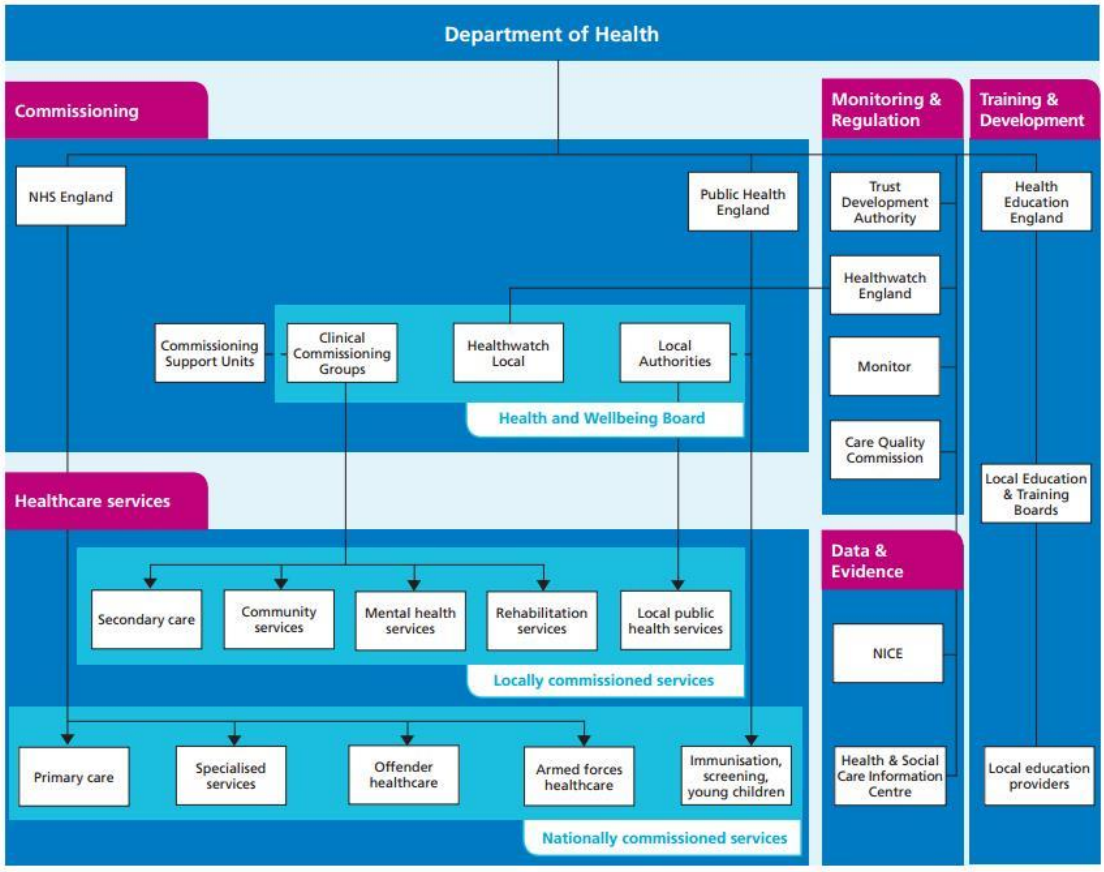

Figure 1.3: A new UK healthcare structure (NHS England, 2014)

1.3 Pharmaceutical services in hospital pharmacies in the KSA and the UK

Secondary care refers to health care provided by hospital clinicians who generally do not have the first contact with a patient, for instance a neurologist or a cardiologist consultant (Multiple Sclerosis Trust, 2015a). Patients are usually referred to secondary care by a primary care provider, such as the primary care centre in the KSA or general practitioner (GP) in the UK. Tertiary care differs from the secondary care in that tertiary care is specialised healthcare provided in specialist centres, usually on referral from secondary care or primary care (Multiple Sclerosis Trust, 2015b). The King Khaled Eye Specialist Hospital in KSA and the National Hospital for Neurology and Neurosurgery in UK are examples of tertiary care centres. Pharmacy department in the

hospital provides essential service in hospitals, and it plays an important role in the drive to reduce patient safety risks (Schwartz and Kravitz, 2015, Robbins et al., 2013). This research is concerned with the King Saud Medical City (SKMC) in the KSA and the Luton and Dunstable University Hospital NHS Foundation Trust (L&D) in the UK, so there is a need to describe the pharmaceutical services in both hospitals.

1.3.1 Pharmaceutical services in the KSMC hospital pharmacy

The pharmacy in the KSMC consists of three main sections: in-patient pharmacy, out-patient pharmacy and Drug and Poison Information Centre (DPIC). Furthermore, there are satellite pharmacies in the intensive care unit, emergency department and kidney centre. The in-patient pharmacy operates 24 hours per day, and provides pharmaceutical care to hospitalised patients in the wards and intensive care units, and to emergency department patients. The pharmaceutical care services in the in-patient pharmacy include the unit dose system, dispensing the discharge prescriptions, and intravenous admixture preparation units, which prepare some medicines, such as antibiotics, total parenteral nutrition and chemotherapy. The out-patient pharmacy services patients of the out-patient clinic through dispensing the out-patient prescriptions. The DPIC provides information on medicines for the healthcare professionals in the hospital and anyone with concerns about poisons or drugs (KSMC, 2015). However, the in-patient pharmacy operated 24 hours for 7 days in three shifts; morning (8 Am - 4 Pm), evening (4 PM – 12 Am) and night (12Am – 8 Am). While the out-patient operated with the out-patient clinics from 8 Am to 4:30 Pm from Sunday to Thursday. In the previous the out-patient pharmacy was operated from Saturday to Wednesday until June 2013 while the weekend in KSA changed to be Friday and Saturday.

The dispensary team in the Saudi hospital pharmacy usually consists of 54 pharmacists and 70 pharmacy technicians. Moreover, there are 20 pharmacists working in the hospitals as clinical pharmacists (Al-Zaagi, 2015). The pharmacists should have a bachelor's degree in pharmacy or a pharm-D, while the pharmacy technicians should

have a diploma in pharmacy. The clinical pharmacists should have a Pharm-D or a clinical pharmacy program diploma (two years long) after the bachelor's degree. The clinical pharmacists can train in advanced clinical pharmacy (three years) to become a specialist in one or more healthcare areas, including the following fields: internal medicine, nephrology, solid organ transplantation, oncology & haematology, infectious diseases, total parenteral nutrition, paediatrics, critical care and internal medicine. They need to register with the Saudi Commission for Health Specialties (SCFHS) after completing the required training program period (SCFHS, 2014).

The pharmacists play a role in improving patient safety in the KSMC. For example, a senior pharmacist works as a medication safety officer. The main role for the medication safety officer is improving the safety of medicines in the hospital through monitoring and reporting medication errors, raising the awareness of professionals about medication errors and implementing and examining medication safety interventions in the hospitals. Moreover, the pharmacist is an important member on some committees, such as the procurement committee and the pharmaceutical and therapeutic committee, which are responsible for the drug formulary in the hospital (Al-Zaagi, 2015).

Clinical pharmacy services were started in Saudi hospitals in the 1980s, but they were limited to some hospitals, such as the King Khalid University Hospital and the King Faisal Specialist Hospital (Saddique, 2012). The clinical pharmacists' numbers are limited in the KSMC, and their roles in the hospital are reviewing the prescribed medicines in the in-patient chart, counselling the in-patients about their medicines, monitoring the pharmacokinetics and therapeutic drug level for narrow therapeutic index medicines and determining doses of medicines for renal and liver failure patients. The main role of the dispensary team in the hospital is dispensing the medicines in the in-patient and out-patient pharmacies (Al-Zaagi, 2015). Dispensing medicines in the hospital is carried out in several stages.

Supply of medicine is part of multidisciplinary process, stated by writing the prescription and ending with the administration of the medication to the patient. There are two different pathway for the supply the medicines in KSMC. One for the admitted patients and the second for the other patient there, who visit the out-patient clinics or emergency department. For the admitted patients, physicians complete the prescription through the electronic prescribing programme. The second step consists of the pharmacy staff checking the electronic prescription information in the pharmacy and matches it with the information in the patient record to avoid prescribing errors and transcribing errors. The information includes the patient's name, route of administration, strength, dose, dosage form, frequency and the patient diagnosis. The label is then created and printed. It should contain the following information: patient's name and patient number, drug name, route of administration, strength, direction of use, quantity, frequency and dosage form. After that, the pharmacy staff prepare the medications and put each item in a zip-lock bag; a label is then adhered to the bag for the respective patient/medication. The next step is for the medicines to be placed in the patient's drawer in the ward cart. The pharmacist then double checks that the medicines and labels match with the patient's prescription. Nurses are also asked to be vigilant and check the medications before they are administered to the patients.

The medicine supply chain for the patients who came to out-patient clinics or emergency department started by complete the prescription by the physicians through the electronic out-patient prescription system. The following information is among that required: patient name and patient number, date of birth, gender, the patient diagnosis, allergies, medicine name and strength, duration, dosage form and route of administration. The patient then needs to go to the out-patient pharmacy and hand over the printed prescription to the pharmacy staff. The pharmacy staff will then prepare the patients' medications. Firstly, the pharmacy staff will check the information in the prescription and then create and print the label. This label should include the personal details of the patient, as well as important information about the medicine. The next step involves assembling the medicines by using baskets or boxes, and then sticking the label onto each set of medicines. The pharmacist then double

checks that the medicines and labels match with the patient's prescription. At the final stage, the medicines are handed to the patient and counselling provided by the pharmacy staff, as and when necessary.

Despite the medication use process in the KSMC having been designed to improve patient safety, a lot of errors occur during that process. For example, 1,025 medication errors were reported in King Saud Medical City during a six month period only (January 2012 to June 2012); most of these errors were transcribing, prescribing and dispensing errors (Al-Zaagi et al., 2013). Aljadhey et al. (2014) conducted a study to investigate some of the challenges to improving medication safety in KSA hospitals. Lack of research, lack of patient safety programmes in hospitals, and lack of monitoring and reporting of medication errors are barriers reported to hinder the improvement of medication safety in the KSA.

1.3.2 Pharmaceutical services in the L&D hospital pharmacy

The pharmacy staff in L&D hospital consists of 29 pharmacists, 27 pharmacy technicians, 13 pharmacy assistants and support staff, such as secretarial staff, procurement officers, patient safety officers and storekeepers (Cox, 2014). The pharmacists should have a Master of Pharmacy (MPharm) degree and a one-year pre-registration training accredation in pharmacy practice. The pharmacy technicians should have a diploma in pharmaceutical science (or equivalent), whereas the pharmacy assistants are required to have a minimum level of pharmacy training to work on the dispensary (NVQ). Pharmacists and pharmacy technicians have to be registered with the General Pharmaceutical Council (GPhC) (General Pharmaceutical Council, 2015).

The L&D hospital has one main pharmacy and satellite pharmacies on some wards. The pharmacy department in L&D provide multi-services, such as dispensing medicines for in-patients and out-patients, preparing total parenteral nutrition and chemotherapy, and other services provided through the clinical pharmacists. The clinical pharmacists in L&D have several roles, including checking and monitoring prescriptions,

assessments of prescription charts, providing advice to medical and nursing staff (medicine information pharmacists), monitoring and reporting medication errors and adverse drug reactions, taking medication history, educating and counselling the patients, and monitoring the pharmacokinetics and therapeutic drug levels.

Medicines supply in the L&D consists of several steps, triggered by writing the prescription manually or my computer for the discharge patient. After receiving a prescription, a pharmacist will check the validity of the prescription to check it is written correctly and contains all the information needed to dispense the medicine. Also, the pharmacist will perform a clinical screen to check dosage and other potential issues, such as drug-drug or drug-disease interactions. The next steps are the assembling and labelling of the medicines. A dispensary team member will enter the prescription in the computer system (JAC system), print the labels and then assemble the medicines. Thereafter, he/she will attach the labels on the corresponding medicines after double checking that he/she collected the right medicines and created the right information in the labels. However, some hospitals have an automation system; in that case the majority of the medicine's assembling is carried out by the automation system directly after the printing of the labels. The last step before handing over the medicines is the final accuracy check by a qualified person who was not usually involved in the assembling or labelling process. For the admitted patient, the medicines send to the ward in keep in a cupboard beside the patient bed. Separate lockable cupboards should be available in the UK hospitals to keep the internal and external medicines (Stephens, 2011).

1.3.3 Medicines supply chain differences and similarities of the two hospitals

The medicine supply chain nearly same in the both hospital but there are some differences, which are;

- In KSMC, the physicians prescribe the medicines only through the electronic prescribing system that available in the hospital. While in L&D usually using the handwriting prescription.

- Clinical screen is an extra step on the dispensing process in L&D. while, it absent in the current dispending process in KSMC related to lack of clinical pharmacists in the hospital.
- The majority of the medicines are assembling by using an automation system in L&D. while the assembling the medinces in KSMC done manually.
- In KSMC, the medicines are supplied to the admitted patients though using unit-dose system. While in L&D the medicines for each patients are keep in a cupboard beside the patient bed.

1.4 Medicine related problems

Medicine related problems (MRPs) cause considerable patient morbidity, mortality and increased healthcare cost (Ernst and Grizzle, 2001). The published studies estimated that about 5–10% of hospital admissions were due to MRPs (Conforti et al., 2012, Nivya et al., 2015, Stausberg and Hasford, 2011). Currently, a systematic review conducted by Al Hamid et al. (2014) showed that MRPs have a high prevalence, and in some studies the rate of MRPs was more than 50%. MRPs are ranked as between the 4th and 6th leading cause of death in USA, and they are responsible for the admission of 700,000 patients to hospitals annually (Budnitz et al., 2006). It is suspected that approximately 3% of deaths in the Swedish population are because of MRPs (Wester et al., 2008).

An MRP is defined as *"an event or circumstance involving drug therapy that actually or potentially interferes with desired health outcomes"* (PCNE, 2010). MRPs consists of three subgroups: Medication Errors, Adverse Drug Events (ADEs) and Adverse Drug Reactions (ADRs) (Al Hamid et al., 2014). The simplest definition of ADEs is *"An injury or harm resulting from medical intervention related to a drug"* (Bates et al., 1995). An ADR is defined as *"Any response to a drug which is noxious and unintended, and which occurs at doses normally used in man for prophylaxis, diagnosis, or therapy of disease, or for the modification of physiological function"* (WHO, 1999). However, not all

medication errors are MRPs: medication errors are not considered to be MRPs if there is no potential risk outcomes in the patient (van Mil, 2005). There are interactions between these subgroups, and Figure 1.4 shows the relationship between medication errors, ADEs and ADRs.

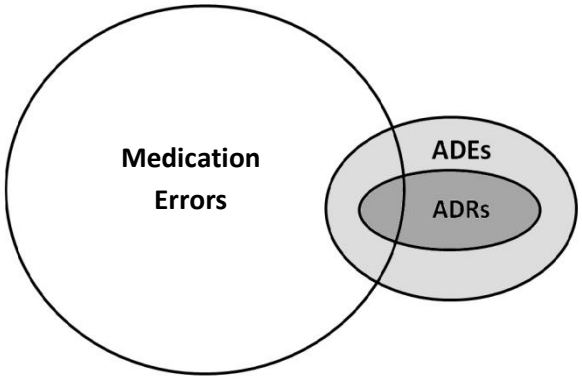

Figure 1.4: Relationships between MEs, ADE and ADR (Bates et al., 1995).

Patent safety incident types include clinical administration, documentation, health care associated infection, clinical process/procedure, medication, blood products, nutrition, oxygen/gas supply, medical device, behaviour, patient accidents, infrastructure, and organisational/resources management (WHO, 2009a). However, MEs are one of the most common patient safety incidents reported in healthcare institutions (Cousins et al., 2012, Milch et al., 2006). In the UK, about 15% of the patient safety incidents that were reported to the National Reporting and Learning System (NRLS) in 2004 were medication errors (NHS, 2015b). In Canada, up to 50% of the patient safety incidents in primary care are related to medication errors (Ospins et al., 2010).

1.5 *Medication errors*

Hospitals and healthcare professionals aim to provide high quality and safe medical care to their patients, including the safe and effective use of medications. These medications, however, can be compared to a two-edged sword; while useful, they can also be harmful as a result of errors associated with their use, as well as from adverse events/effects (Naylor, 2002). The definition of a medication error varies widely in the literature (Lisby et al., 2012, Salmasi et al., 2015, Alsulami et al., 2013). The most common used definition is that given by the National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP) in the USA, which defines medication errors 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 healthcare professional, patient, or consumer. Such events may be related to professional practice, healthcare products, procedures, and systems, including: prescribing; order communication; product labeling, packaging, and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use." (NCCMERP, 2015)*

The occurrence of medication errors is a widespread problem in hospitals and healthcare organisations, by which potential harm to patients could be caused (Knudsen et al., 2007, Hicks et al., 2004, Barker et al., 2002). For example, 78% of serious medical errors in intensive care units (ICUs) at urban hospitals in Canada are related to medication errors (Rothschild et al., 2005). In England and Wales, approximately 80,000 MEs were reported to the National Reporting and Learning System (NRLS) by NHS organisations between 1st October 2013 to 31st March 2014 (NPSA, 2014). Preventable medication errors could cost more than £750 million annually in England (Cousins et al., 2007). Preventable medication errors cost the USA about $20 billion each year (IMS Institute for Healthcare Informatics, 2013). In

Australia, about 3% of all hospitalised patients are admitted to hospitals because of medication errors (Roughead and Semple, 2009).

Medication errors can be classified according to contextual categories, such as their stage of occurrence. So, in accordance with the medication use process, medication errors can be classified as prescribing errors, transcription errors, dispensing errors, administration errors, counselling errors or monitoring errors (Knudsen et al., 2007). It is important to note that the medication use process is a chain of stages, and any fault in one of these stages may lead to harm to the patient.

1.5.1 Stages of the medicines use process in hospitals

In general, there are six main stages through which medications are processed in hospitals (known as the "medication use process"), beginning with the stage in which a medicine is prescribed to a patient and continuing throughout the time they are using the medicine, as well as while the outcomes of using the medication are monitored (see Figure 1.5). The first stage focuses on the time at which a medicine is prescribed to the patient. Often, there are three types of prescription: discharge, out-patient and medicine charts (L&D, 2013). Lewis et al. (2009) conducted a study to review prescribing errors in hospitals. The median rate of prescribing errors in the reviewed studies was 7% of the prescribed medicines. This review shows how the prescribing errors are prevalent during the administration stage. However, one of the limitations in this review was that, it included studies were the short duration of data collection and the use of estimated denominators in some studies and that can effect in the errors rate. In England and Wales, 15.7% of the medication errors that were reported to the National Reporting and Learning System (NRLS), between January 2005 and June 2006, were prescribing errors (NPSA, 2007c).

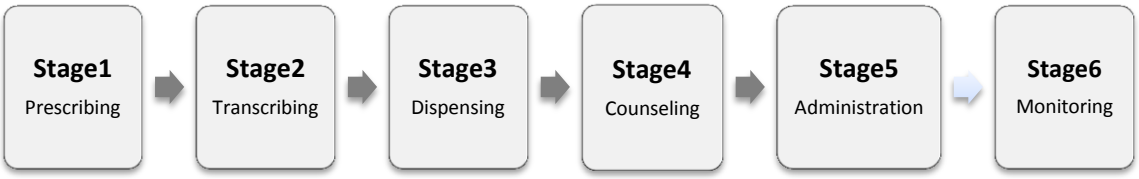

Figure 1.5: The medicines use process (Cohen, 2007).

The second stage concerns the transcribing of the prescription. This step is not always necessary, as it depends on the prescribing system in the hospital; for example, some hospitals have Computerized Physician Order Entry (CPOE) systems (Cohen, 2007, AHRQ, 2014). As such, the transcribing stage is not needed for all cases/hospitals. Transcribing of the prescription can be in two different ways, by written the prescribed medicine verbally order or by interpreted the handwriting prescription (Cohen, 2007). Some studies reported a high rate of transcribing errors; for example, transcribing errors made up 53% of the identified medication errors in a Swiss university hospital related to the poor handwriting (Hartel et al., 2011). In a Saudi hospital, transcribing errors made up 49% of the total reported medication errors because the breakdown the communication between the physicians and nurses during the verbal order (Al-Dossari et al., 2014).

The third stage of the medicines use process is the dispensing stage. Often the dispensing process is carried out by the dispensary team in a hospital pharmacy. Little research has been conducted to investigate dispensing errors in hospital (James et al., 2009). The research shows high rate of dispensing errors reported in some counties; for example, in Brazilian hospitals the rate of dispensing errors was 11.5%–33.5% of the total dispensed items (Anacleto et al., 2005, Bonifacio Neto et al., 2013, Costa et al., 2008). This variation in dispensing error rate might be due to differences in the dispensing system, research methods or the dispensing error classification used in the Brazilian studies (Rissato and Romano-Lieber, 2013).

The next stage is counselling the patients about their medicine. This process is one the most effective interventions that can enhance patient safety. Researcher have shown

that 83% of errors were identified during counselling patients about their medicine (Kripalani et al., 2012, Anacleto et al., 2005).

The fifth stage of the medicines use process is the administration stage. In the hospital, the patient medicines are stored in drug trolleys or individual patient lockers. At the required time, the nurse administers the medication to the patient and documents having done so the medication chart (Lawson and Hennefer, 2010). A lot of the medication errors reported related to errors during administering the medicine to the patient. For example, In England and Wales, 59% of the medication errors that were reported to the National Reporting and Learning System (NRLS) between January 2005 and June 2006 were administering errors (NPSA, 2007c).

The last stage of the medicines use process is the monitoring stage. In particular, those who are conducting the monitoring should evaluate their patients to check for toxicity and other side-effects from the drugs that are administered. They should also monitor the effectiveness of the drug in relation to its prescription. If these activities are not carried out in an effective manner, errors may result (Cohen, 2007). Monitoring errors are limited and little research has been carried out on errors during the monitoring stage. In Saudi hospitals, the percentage of the monitoring errors was only 2% of the reported medication errors (Al-Dossari et al., 2014).

Most published studies indicate that medication errors most commonly occur during the prescription, administration and dispensing stages (Alakhali et al., 2014, Karthikeyan and Lalitha, 2013, Kirke, 2009, NPSA, 2007c, Lisby et al., 2005). In England and Wales, of the 60,000 medication errors reported to the National Reporting and Learning System (NRLS) between January 2005 and June 2006, around 59% occurred during the administration stage, 17.8% occurred during the dispensing stage, and 15.7% occurred during the prescription stage (NPSA, 2007c).

Three systematic review studies concerning medication errors (Salmasi et al., 2015, Alsulami et al., 2013, Ghaleb et al., 2006) found that most of the previously published studies of medication errors had focused on prescription errors and administration

errors, with few investigating dispensing errors. This study will consider medication errors with a special focus on dispensing errors.

1.6 Dispensing

Dispensing medication consists of several stages, and dispensing errors can occur at any of these stages.

1.6.1 The Dispensing Process

Dispensing medication is a complex process that involves more than simply taking medicine from a pharmacy shelf, giving it to the patient after putting it in a container, and then sticking a label on the pack (Kelly, 2011). The process begins with the receipt of the prescription from a patient or their representative (carer or healthcare professional), and ends with the distribution of the medicine to the patient or the patient's representative (NPSA, 2007a). These stages are outlined below in Table 1.1.

Table 1.1: The general dispensing process in community and hospital pharmacies in the UK

(James et al., 2009, NPSA, 2007a)

Dispensing stages	Details
Receiving a prescription	- Validation of patient information - Check prescription fulfils legal requirements - Place the prescription in the designated area for processing.
Clinical check by the pharmacist	- Confirm that the prescribed medicines and dosages are appropriate for patient. - Check the drug-drug interactions and drug-disease interactions.
Label and assemble	- Prepare and print the labels. - Collect all the stock required for the prescriptions in a suitable container and check the stock expiry dates. - Count or measure the quantity of the medicines. - Attach the labels on the corresponding medicine vessels.
Accuracy check by pharmacist or accuracy checking technician	- Conduct an accuracy check for each item. A qualified person who has not been involved in the assembly or labelling process should ideally complete the accuracy check. - Check the stock container of the products against the prescription to confirm the drug names, dosage forms, strengths, and dosages. - Check the labels against the prescription to confirm the drug names, dosage forms, strengths, and dosages. - Check the patient information. - Check the expiry date of the items.
Handing over the medicine to the patient or the patient's representative	- Ask the patient his or her name. - Ask the patient his or her address for confirmation of identity. - Supply dispensed medication to appropriate patient representative (carer, healthcare professional) following local guidelines. - Counsel as appropriate

The entire dispensary team must understand and follow a standard set of rules and operating procedures in order to avoid errors during the dispensing process (Cohen, 2007).

1.6.2 Dispensing errors

It is reported that more than 1 billion prescriptions were dispensed in pharmacies in England in 2012 (HSCIC, 2013) and about 4 billion prescriptions are dispensed every year in the USA (IMS Institute for Healthcare Informatics, 2014). Dispensing errors are one of the most common medication errors incidents reported in hospitals. In the UK, 19.4% of medication errors in 2013 were the result of dispensing errors that occurred in general, acute or community hospitals and it is came after the administration errors (42.7%) and prescribing errors (20.7%) (Gerrett, 2015). In the USA, Flynn et al (2003) observed four dispensing errors per 250 prescriptions in 50 hospital and community pharmacies. The most common errors were dispensing an incorrect medication, dosage strength, or dosage form.

1.6.3 Causes of dispensing errors

Healthcare professionals are human beings, and they are, therefore, fallible. However, any error in a healthcare organisation may put the patient's life in danger. Understanding why errors occur, as well as how human factors impact those errors, can help to decrease the number of errors in the healthcare system. One of the most referenced models for evaluating the possible causes of errors and accidents is the “Swiss Cheese Model” (see Figure 1.6), first proposed by James Reason. Reason’s model hypothesises that any system has many levels of defences, and he compares those defence levels to multiple slices of Swiss cheese. Each slice has safeguards that can prevent hazards, but there are holes in defences that are caused by active failures and latent conditions that can result in errors or accidents (Reason, 2000).

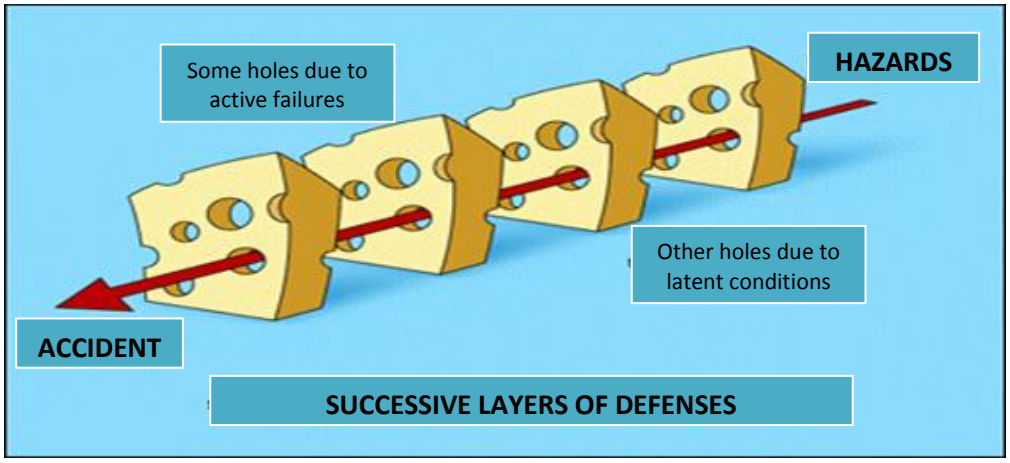

Figure 1.6: Swiss Cheese Model (Reason, 2000)

Systems have several properties that can make people more susceptible to making errors; these are called “latent conditions” (Moyen et al., 2008). Latent conditions are factors that can facilitate the occurrence of errors, for instance, during the medication dispensing process, which could be a result of work overload or poor staff training (Aronson, 2009). People who are in a direct relationship with the patient, on the other hand, usually cause active failures. Fatigue, drug and/or alcohol use, stress, and doing multiple activities can increase the risk of active failures by diverting attention away from the patient (Moyen et al., 2008). Within a healthcare setting, when a latent factor and an active failure are combined, all levels of defences are broken, resulting in a patient safety incident.

There are two main types of errors that are due to human factors (active failure): skill-based errors and mistakes (see Figure 1.7). Skill-based errors are those errors that occur during the execution of what is otherwise a correct plan. Skill-based errors, in themselves, may be classified according to two types. The first type comprises action-based errors (also described as slips). An example of a slip is a case in which the pharmacy staff intends to take a bottle containing chlorpromazine, but instead picks up a bottle containing chlorpropamide. The second type of skill-based error consists of memory-based errors (also described as lapses). An example of a lapse is giving

penicillin to a patient who is known to have an allergy to penicillin, but forgetting. Mistakes, on the other hand, can be defined as errors that originate in the (wrong) planning of an action. (Aronson, 2009, Hurwitz and Sheikh, 2009, Williams, 2007).

Mistakes may be related to knowledge-based errors, for example, giving medication without establishing whether the patient is allergic to it in the absence of knowledge about the patient's allergies, or rule-based errors (Williams, 2007). Rule-based errors can be further conceptualised as using a bad rule, for example, excessive doses of captopril were administered during early use of the drug, or misapplying a good rule, for example, injecting a medication into a non-preferred site (Aronson, 2009, Williams, 2007, Ferner and Aronson, 2006).

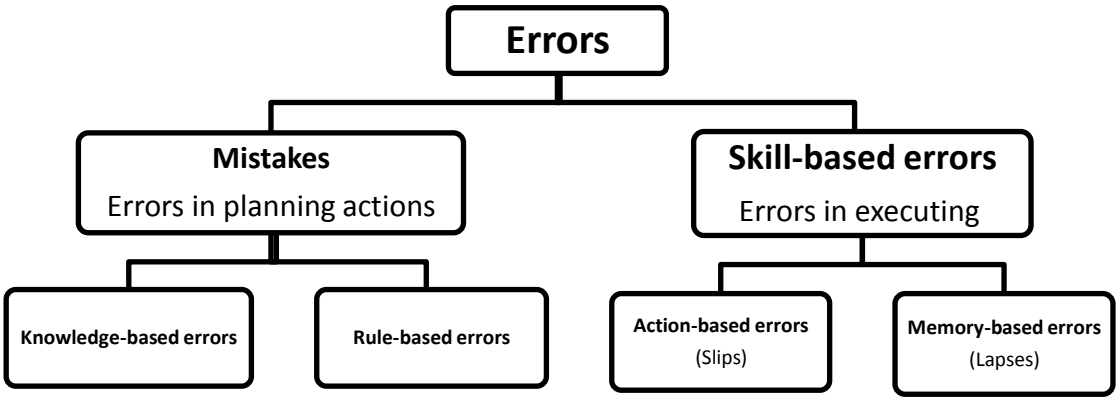

Figure 1.7: The classification of active failure based on a psychological principle (Aronson, 2009)

1.7 Concerns about dispensing errors (rationale for this study)

Limited studies have investigated the types and contributory factors of dispensing errors, along with their severity. These studies were conducted mostly in the USA, European countries, Brazil and Australia. The types and causes of dispensing errors may differ from country to country as a result of their respective healthcare systems. To illustrate this, the KSA has a different healthcare system than that of European counties and the USA. However, to our knowledge, no published study has been conducted to investigate dispensing errors in the KSA, or in any of the other Arab counties.

Despite the limited number of studies of dispensing errors, some studies have focused on the rates and types of dispensing errors, rather than addressing the reasons for dispensing errors and how to reduce them (Bohand et al., 2009a, Bohand et al., 2009b, Franklin and O'Grady, 2007). For instance, Anacleto et al. (2007) focused only on the frequency of errors, but failed to place much focus on the reasons behind these errors.

Furthermore, an important suggestion for preventing dispensing errors involves not only reporting the errors, but also talking openly about the issues pharmacy staff experience, in order to raise awareness of the errors and help their prevention. Teinila et al. (2009) conducted a study of 500 Finnish pharmacies (by analysing the structured responses of the pharmacies), and found that pharmacists believe that it is important to discuss errors among pharmacy staff in order to make changes in normal work routines; this helped ensure that certain errors that were based on specific factors were prevented.

The above evidence, therefore, justifies the need for research in hospital pharmacies in order to investigate the types and causes of dispensing errors, and how to prevent these errors in the KSA. It would also be beneficial if an investigation of the types and causes of dispensing errors in advanced healthcare systems, such as those observed in UK hospitals, is carried out to compare with the findings from the KSA, in order to formulate appropriate recommendations to reduce dispensing errors.

This research was conducted in the King Saud Medical City (KSMC) and the Luton and Dunstable University Hospital NHS Foundation Trust (L&D). It has been decided to carry out this research at the KSMC for several reasons. Firstly, the hospital is the oldest and largest hospital in the KSA. Furthermore, the campaign for improving medication safety and patient safety in the KSMC was formally started in Jan 2012 (Al-Dossari et al., 2014). It included reporting medication errors in order to improve patient safety in the hospital. Also, it has been decided to carry out this research at the L&D, as it treats participating in such programmes, either nationally or internationally, as a priority, since focusing on patient care requires improving the safety of patients in the hospital and reducing the risk of adverse events. These programmes include: 'Pursuing Perfection: Raising the Bar for Health Care Performance'. This programme was started in 2001 by 13 participants from Europe and the United States to improve patient outcomes by pursuing perfection in their major healthcare processes. In addition, L&D took part in the 'Safer Patients Initiative', a national programme established by the Institute for Healthcare Improvement (IHI), intended to make United Kingdom hospitals safer for patients. Accordingly, since this project focuses on patients' safety via reducing dispensing errors that occur in hospitals, the L&D was one of the most appropriate sites based on their reputation and work on the patient agenda to undertake this study.

1.8 Research Questions

1.8.1 Primary question

- What is the nature and severity of dispensing errors reported in pharmacies at the King Saud Medical City (KSMC) Hospital in the KSA, and at the Luton and Dunstable Hospital (L&D) NHS Foundation Trust in the UK?

- What are the perceptions of the dispensary teams about the contributory factors to dispensing errors?

- What are the best strategies to reduce dispensing errors according to the dispensary teams' perceptions?

1.8.2 Secondary questions

- What are the types of dispensing errors reported in pharmacies at the KSMC Hospital in the KSA, and at the L&D Hospital in the UK?

- What are the best applied strategies or intervention in KDMC and L&D to reduce dispensing?

1.9 Aim and Objectives

1.9.1 Aim

To determine the nature and severity of dispensing errors reported in the hospital pharmacies at the King Saud Medical City (KSMC) Hospital in the KSA, and at the Luton and Dunstable Hospital (L&D) NHS Foundation Trust in the UK, and to explore the pharmacy staff's perceptions of the contributory factors to dispensing errors.

1.9.2 Objectives

The specific objectives of this study, with regard to pharmacies at the KSMC Hospital in the KSA and the L&D Hospital in the UK, are:

- To identify types of medication errors reported retrospectively.
- To identify types of dispensing errors reported retrospectively.
- To assess the dispensing error severity.
- To ascertain perceptions regarding factors contributing to dispensing errors from pharmacy staff.
- To explore the dispensary teams' perceptions about possible strategies to reduce dispensing errors.

To justify the rational for this study, a systematic review of the nature of dispensing errors in hospital pharmacies was undertaken and it presented in the following chapter.

Chapter 2: A systematic review of the nature of dispensing errors in hospital pharmacies

2.1 Introduction

Medication error is one of the most common patient safety incidents reported in hospitals (Milch et al., 2006, Cousins et al., 2012). In England and Wales, approximately 80,000 medication errors were reported to the NRLS by NHS organisations between 1st October 2013 and 31st March 2014, (NHS, 2014b). Approximately 17% of these errors were the result of dispensing errors. Studies conducted on dispensing errors show a high rate of dispensing errors of between 0.04% and 24% in community pharmacies (Franklin et al., 2014).

In a UK hospital pharmacy, about 2% of dispensed items had dispensing errors; these errors were identified at the final accuracy checking stage (Beso et al., 2005). Many hospital pharmacies collect data regarding dispensing errors identified in the final accuracy checking stage, in order to investigate contributing factors and to develop strategies to prevent or reduce these errors (Royal Pharmacetical Society, 2015). Despite this, are a lot of errors continue to occur in the dispensing process, some of these errors leave the pharmacy without being identified. A total of 1,005 unprevented dispensing incidents were reported by 20 hospitals in Wales between January 2003 and December 2004 (James et al., 2008).

Despite the frequency of dispensing errors in hospitals, less attention has been paid to these in published studies, in comparison to prescription and administrative errors (Irwin et al., 2011, James et al., 2011b, Franklin et al., 2009, James et al., 2009). There are a limited number of studies that have reported on dispensing errors in community and hospital pharmacies; however, one review study (James et al., 2009) was conducted in 2008 to evaluate these studies. The present study focuses on reviewing dispensing errors in hospital pharmacies only, as this is a specific interest and does not involve working patterns or systems between the community and hospital pharmacies.

Accordingly, it allows the researcher to focus purely on hospital pharmacies, characterised by different dispensing systems across different hospitals. This systematic literature review therefore aims to investigate the incidence types and factors associated with dispensing errors in hospital pharmacies, as reported in published literature.

2.2 Methods

The PubMed, Scopus, Ovid and Web of Science electronic databases were used to identify relevant published articles from January 2000 to January 2015. This study considered to review studies published after 1999, while the patient safety gained more attention after the publication of the IOM report entitled "To Err is Human". The keywords used to search for the relevant studies were as follows: Dispensing, Drug(s), Medication, Medicine(s), Error(s), Incident(s), Near miss(es), Mistake(s), Hospital, Secondary care, Inpatient, Outpatient, Pharmacy, Pharmacist, Dispensary.

2.2.1 Inclusion and exclusion criteria

'Dispensing error' for the purpose of this review refers to any error occurring at any dispensing stage in a hospital pharmacy, whether discovered in the pharmacy department or after the medication has left the department. All studies investigating types and/or incidence and/or factors contributing to dispensing errors were included. Studies had to have been undertaken in hospital pharmacies and published in the English language between January 2000 and January 2015.

Studies conducted to identify dispensing errors in community pharmacies or ward stocks, or automation dispensing errors were excluded. Case reports were not been included in this systematic review as they did not reflect the incidence of dispensing errors or their nature. Also excluded were all general medication error studies not specific to dispensing errors, as well as conference papers, as they did not have

provide enough data. Furthermore, reviews, opinions and editorial papers were excluded, as they did not primary sources.

2.2.2 Study *selection*

Initially, the literature search was conducted by the researcher; then, titles were exported from the databases into Endnote X7. All the titles were screened by the researcher to identify relevant studies; abstracts were then examined by the first author and Supervisor to determine the relevance of studies in terms of meeting the criteria, and to exclude irrelevant titles. The remaining studies were assessed independently by the supervisor.

2.2.3 Quality assessment

The quality of all selected studies was assessed using 12 criteria outlined by Allan and Barker (Allan and Barker, 1990) and modified by Alsulami *et al*. and Ghaleb *et al.* (Alsulami et al., 2013, Ghaleb et al., 2006) in order to apply to any type of medication error study. These researches conducted to review medication errors studies and this review consider about the dispensing errors. So the definition of what constitutes a medication error was changed to a definition of what constitutes a dispensing error. The selected studies had to satisfy a minimum of 6 criteria from the list below to be sure to choose a good studies.

1. Aims/objectives of the study clearly stated
2. Definition of what constitutes a dispensing error
3. Error categories specified
4. Error categories defined
5. Presence of a clearly defined denominator
6. Data collection method described clearly
7. Setting in which study conducted described
8. Sampling and calculation of sample size described

9. Reliability and validity measures applied
10. Limitations of study listed
11. Indication of any assumptions made
12. Ethical approval obtained

2.3 Results

The keyword search resulted in a total of 3,767 studies across all the databases accessed. Duplicate studies were excluded, bringing the total down to 2,929. Following this, article titles and abstracts were reviewed and any irrelevant studies were excluded, which resulted in 2,908 articles being discarded. Finally, the remaining 21 articles were assessed for suitability, of which 15 publications fulfilled the inclusion criteria (Figure 2.1). All of these 15 studies were conducted in just four countries: the UK (6), Brazil (4), USA (3) and France (2).

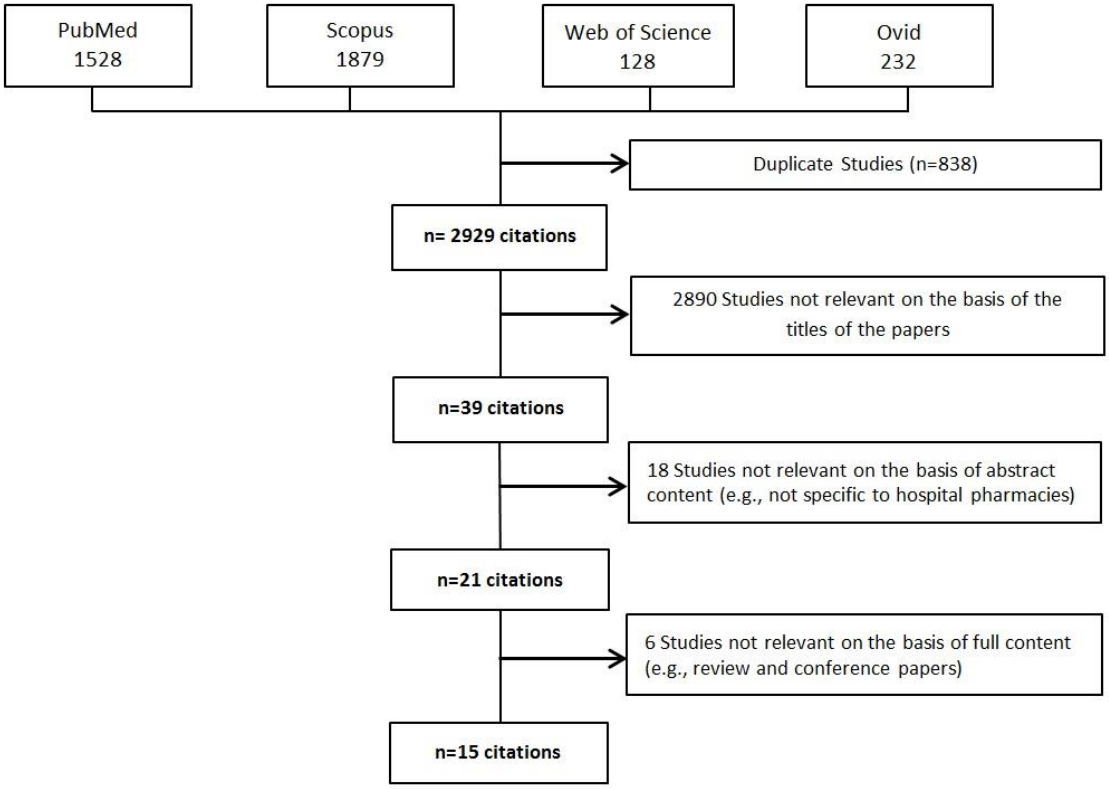

Figure 2.1: Summary of the literature search

2.3.1 Quality assessment

The results of the application of the quality assessment criteria were that one of the selected studies fulfilled eleven criteria (James et al., 2011b), one met ten criteria (James et al., 2008), four met nine criteria (Bonifacio Neto et al., 2013, Bohand et al., 2009b, Cina et al., 2006, Beso et al., 2005), four met eight criteria (Irwin et al., 2011, Bohand et al., 2009a, Costa et al., 2008, Anacleto et al., 2005), three met seven criteria (Rissato and Romano-Lieber, 2013, Anto et al., 2011, Seifert and Jacobitz, 2002) and two met six criteria (Anto et al., 2010, Rolland, 2004). Only eight studies had obtained ethical approval (Anacleto et al., 2007, Anto et al., 2010, Beso et al., 2005, Bohand et al., 2009b, Bonifacio Neto et al., 2013, Costa et al., 2008, Irwin et al., 2011, Rissato and Romano-Lieber, 2013). Two studies reported that ethical approval was not required (James et al., 2008, James et al., 2011b), and five did not clearly state whether ethical

approval had been obtained or not (Anto et al., 2011, Bohand et al., 2009a, Cina et al., 2006, Rolland, 2004, Seifert and Jacobitz, 2002). However, some of the ethical committee duty to assess the quality of the research, which can help to improve the study quality (Griffin, 2011) .

2.3.2 Research methods used in selected studies.

Two primary approaches of identifying dispensing errors on the selected studies: retrospective studies and prospective studies. Six studies were retrospective, of which five studies were conducted by reviewing incident that reported in the hospital (James et al., 2011b, Irwin et al., 2011, Anto et al., 2010, James et al., 2008, Rolland, 2004), and one was conducted by reviewing patients' charts in the hospital (Seifert and Jacobitz, 2002). By contrast, eight were prospective studies, of which seven used the direct observation method for the dispensary team (Bonifacio Neto et al., 2013, Rissato and Romano-Lieber, 2013, Bohand et al., 2009b, Bohand et al., 2009a, Anacleto et al., 2007, Cina et al., 2006, Costa et al., 2008), one was conducted by used face-to-face interviews with the dispensary team to investigate factors associated with labelling errors (Anto et al., 2010).

One study used a mixed method approach; the first part focused on observation to detect dispensing error types, and the second part involved interviewing the dispensary team to investigate the causes of dispensing errors (Beso et al., 2005). All Brazilian studies employed direct observation to investigate dispensing errors (Anacleto et al., 2007, Bonifacio Neto et al., 2013, Costa et al., 2008, Rissato and Romano-Lieber, 2013). By contrast, the majority (4/6) (Anto et al., 2011, Irwin et al., 2011, James et al., 2011b, Anto et al., 2010, Costa et al., 2008, James et al., 2008) of UK studies relied on retrospectively reviewing incident reports. A brief description of these studies is presented in Table 2.1.

Table 2.1: Description for the identified published studies

Study	Country	Type of Study	Duration	Setting	Outcomes	Incident Rate
James et al (2011b)	**UK**	Retrospective, analysed prevented and unprevented DEs reported to UK dispensing error analysis scheme (UKDEAS)	(Three months) Sep.-Dec. 2005	17 acute hospitals in Wales	334 dispensing errors reported; 35 unprevented DEs and 339 prevented DEs. 54% (157) of prevented DEs and 37% (13) of unprevented DEs were labelling errors e.g. labelling wrong drug (prevented, n=15; unprevented n=6). Dispensed wrong drug strength (prevented, n=46; unprevented n=2). Look-alike/sound-alike, high workload and inexperienced staff were the most commonly contributed factors reported.	Prevented DE 0.13% Unprevented DE 0.016%
Irwin et al (2011)	**UK**	Retrospective, analysed incident reports	(5 years) July 2005-March 2010	25 Scottish hospitals	573 dispensing errors reported; the most frequent dispensing error types were dispensed wrong drug 110 (19.2%) and dispensed strength 96 (16.8%). The most frequent distributed factor reported were the medicines' similarity in name, high workload and inexperienced staff.	NA
James et al (2008)	**UK**	Retrospective, analysed incident reports	(Two years) Jan. 2003-Dec. 2004	20 Welsh NHS hospital pharmacies	1005 dispensing errors reported to UKDEAS; the most frequent errors were dispensed incorrect strength 241 (24%), incorrect drug 168 (17%) and wrong form 134(13%). The most common medicine involved in DEs was insulin (n=34).). Look-alike/sound-alike, high workload, low staffing and inexperienced staff were the most commonly contributed factors reported.	NA
Beso et al (2005)	**UK**	Prospective by identified DEs in the final check, then interview with pharmacy staff who made the error to explore the causes.	(Two weeks) 17-28 June 2002	Teaching hospital in London (450bed)	130 dispensing errors were observed from 4849 observed dose; dispensed wrong quantity was the most common errors (n=38, 29%) then labelling wrong quantity (n= 18, 13.8%). High workload, low staff, interruptions, look-alike/sound-alike and lack of knowledge about the availability of different medicines and formulation were the most common reported contribution factors.	2.7%
Anto et al (2011)	**UK**	Retrospective, analysed incident reports	(4 years) Jan. 2005 – Dec. 2008	Two main pharmacies at NHS Foundation Hospital Trust in London (1200 beds)	911 prevented and unprevented dispensing errors; the most frequent DEs were dispensing wrong strength 13.4% (n=122), dispensing wrong drug 7.13% (n=65) and dispensing wrong form 2.6%.	NA
Anto et al (2010)	**UK**	Prospective, face-to-face interviews	(3 months) Sep.-Nov. 2008	A 1200 bed NHS Foundation Trust	42 labelling incidents were recorded. The most common contributed factors were: high workload, limited staff, lack of knowledge, lack of concentration, hurrying through tasks and illegible handwriting.	NA
Neto et al (2013)	**Brazil**	Prospective, direct observation	(Two months) July-August 2011	Central pharmacy, unit dose for cardiovascular and pulmonary ward (36 beds) of the 280 bed university hospital	1611 dispensing errors were detected from 4837 dispensed items; dispensed medicines without the described pharmaceutical form was the most common error (n=1396, 86.6%).	33.3%

DEs = dispending errors

NA = number of dispensed items is unknown

Table 2.1 (*Continued*)

Study	Country	Type of Study	Duration	Setting	Outcomes	Incident Rate
Anacleto et al (2005)	**Brazil**	Prospective, direct observation	(21 days) September 2002	Unit dose in Belo Horizonte hospital pharmacy (286 beds)	719 dispensing errors were detected from 2143 dispensed items; the most frequent DEs were dose omission (n=412, 57.3%) and dispensing wrong quantity (n=91, 12.7%).	33.6%
Rissato and Romano-Lieber (2013)	**Brazil**	Prospective, direct observation	(16 days) 4-19 Jan. 2010	Central pharmacy, unit dose for surgical ward (30 beds) of university hospital (104 beds)	61 dispensing errors were observed from 1963 prescribed drug items; the most frequent DEs were dose omission 14 (23%) and dispensed non-prescribed medication.	3.1%
Costa et al (2008)	**Brazil**	Prospective, direct observation	(27 days) 25 Aug.- 20 Sep.	Central pharmacy, unit dose at pediatric hospital (96 beds)	300 dispensing errors were observed from 2620 observed dose. 43.3% missing dose, 25% dose added and 13.3% omission.	11.5%
Rolland (2004)	**USA**	Retrospective, analysed incident reports	(4 years) Oct. 1997- Sep. 2001	Eight different sections at Central Arkansas Veterans System (CAVHS)	82 dispensing errors were reported; dispensing wrong medicines (n=31, 37.8%), dispensing to wrong patient (n=24, 29.2%) and dispensing wrong dose (n=21, 25.6%) were the most common DEs types.	NA
Seifert and Jacobitz (2002)	**USA**	Retrospective. Chart review	(35 months) Jan. 1999- Nov. 2002	All drug exposures reported to Midwest regional poison control centres	40 dispensing errors reported among of 77992 drug exposures reports; 20 DEs (50%) were substitution errors and 17 DEs (42.5%) were labelling errors.	0.05%
Cina et al (2006)	**USA**	Prospective, direct observation	(7 months) Feb.- Aug. 2003	Central pharmacy, unit dose at tertiary academic medical centre (725 beds)	5075 dispensing errors were observed from 140,755 dose; 4016 DEs prevented and 1059 were unprevented DEs. The most frequent dispensing error types were dispensing wrong quantity (n=2978, 59%), wrong strength (n=571, 11%) and wrong drug (n=554, 11%).	3.6%
Bohand et al (2009b)	**France**	Prospective, direct observation by pharmacists and nurses to detect unit dose DEs	(Two months) March-April 2007	Central pharmacy, unit dose for cardiovascular ward (30 beds) of the 354 bed Percy military hospital	179 dispensing errors were detected from 7249 units dose filled; the most common dispensing error types were incorrect dose 57 (31.8%) and omission 54 (30.2%). 86.6% of the dispensing errors (DEs) detected by pharmacists during final check.	2.5%
Bohand et al (2009a)	**France**	Prospective, direct observation	(8 months) April- Dec. 2006	Central pharmacy, unit dose Percy military hospital (354 beds)	706 dispensing errors were observed form 88609 doses; the most dispensing error types were wrong dose (n=265, 37.5%) and omission dose (n=186, 26.3%).	0.8%

2.3.3 Definition of dispensing errors

Six studies reviewed in this paper did not define the term “dispensing error”. However, definitions of dispensing errors were varied in the other published studies (Bohand et al., 2009b, James et al., 2011b, Bonifacio Neto et al., 2013, Beso et al., 2005, Anacleto et al., 2007, Rissato and Romano-Lieber, 2013, Bohand et al., 2009a) (Table 2.2). The definitions given in these studies are very similar; for example, basically the definition of a dispensing error is described as a discrepancy between the prescribed medication and the actual medicine dispensed by the pharmacy. Some studies (James et al., 2011b, Cina et al., 2006) use other definitions to distinguish between a dispensing error that is intercepted before the medicine leaves the pharmacy and after the medicine leaves the pharmacy. The errors that are detected after the medicines left the pharmacy are defined as unprevented (undetected) dispensing errors, and errors that are detected and reported before the medicines leave the pharmacy are defined as prevented (detected or near misses) dispensing errors.

Table 2.2: Definition of dispensing errors

Term	Definition	Reference
Dispensing error	*"A discrepancy between the interpretable written prescription, including modifications made by a pharmacist following contact with the physician or in accordance with pharmacy policy, and the contents of the medication cassette".*	(Bohand et al., 2009a)
	"Deviation from a written prescription/medication order, including pharmacists' written endorsements, occurring during the dispensing process of selecting and assembling medication (drug/content errors), generating and affixing dispensing labels (labelling errors) and issue of dispensed products to patients (issue errors)".	(James et al., 2011b)
	"Discrepancy between the prescribed medication and the content dispensed by the pharmacy".	(Bonifacio Neto et al., 2013)
	"A deviation from an interpretable written prescription or medication order, including written modifications to the prescription made by a pharmacist following contact with the prescriber or in compliance with pharmacy policy".	(Beso et al., 2005)
	Discrepancy between the written instruction found on the prescription order form and the accomplishment of this instruction by the pharmacy when the drug was dispensed to the wards or hospital services	(Anacleto et al., 2007)
	"Any deviation from the written or oral prescription, including written modifications by the pharmacist following contact with the prescriber or in compliance with pre-established norms and protocol, and any deviation from the stipulations of the appropriate regulatory agencies or norms was considered a drug-dispensing error".	(Rissato and Romano-Lieber, 2013)
	"Any discrepancy between dispensed medications and physician orders. Any deviation from standard pharmacy policies".	(Cina et al., 2006)
	"Any discrepancy between the original or modified approved written prescription, and the contents of the medication cassette".	(Bohand et al., 2009b)
Unprevented dispensing incidents	*"Dispensing errors detected after the medication has left the pharmacy".*	(Cina et al., 2006, James et al., 2011b)
Prevented dispensing incidents	*"Dispensing errors detected during the dispensing process before the medication had left the pharmacy".*	(Cina et al., 2006, James et al., 2011b)

2.3.4 Incidence of dispensing errors

This review identified that there is variation in the rates of dispensing errors reported, determined as the number of dispensing errors divided by the number of dispensed items. The dispensing error rate detected using the prospective observation method (Bohand et al., 2009b, Bonifacio Neto et al., 2013, Anacleto et al., 2007, Rissato and Romano-Lieber, 2013, Cina et al., 2006, Costa et al., 2008, Bohand et al., 2009a) was between 0.79% and 33.5%. By contrast, in just two retrospective studies of incident reports (James et al., 2011b, James et al., 2008), the rate of dispensing errors was reported as being between 0.0147% and 0.13%, with more prevented dispensing error rates than unprevented dispensing error rates. In a study by James *et al.* (2011b),

which reviewed incident report to identify dispensing errors, the rate of prevented dispensing errors is reported as 0.13%, and 0.016% for unprevented dispensing errors. By contrast, in Cina et al. study (2006), which used the observation method to detect dispensing errors, the rate of prevented dispensing errors was found to be 2.9%, and 0.57% for unprevented dispensing errors.

2.3.5 Dispensing error types

In the identified published studies of dispensing errors, several categories were used to classify the different types of errors that occured during the dispensing process. Fourteen reviewed studies classified dispensing errors (Anacleto et al., 2005, Anacleto et al., 2007, Anto et al., 2011, Beso et al., 2005, Bohand et al., 2009a, Bohand et al., 2009b, Bonifacio Neto et al., 2013, Cina et al., 2006, Costa et al., 2008, Irwin et al., 2011, James et al., 2008, James et al., 2011b, Rissato and Romano-Lieber, 2013, Rolland, 2004, Seifert and Jacobitz, 2002, Roberts et al., 2002). All of the studies that identified the types of dispensing errors (14/14) reported that dispensing the wrong medicine was one of the most common error types. The rate of that error in reviewed studies were from 0.5% to 51%. Other frequent dispensing errors reported in these studies include dispensing the wrong drug strength (11/14) (5%-37.5%) and dispensing the wrong dosage form (9/14) (1%-26%). Table 2.3 shows the types of dispensing errors cited in the identified published studies.

Table 2.3: Types of dispensing errors reported

	Dispensing errors type \ Reference	(Bohand et al., 2009b)	(James et al., 2011b)	(Irwin et al., 2011)	(Bonifacio Neto et al., 2013)	(James et al., 2008)	(Beso et al., 2005)	(Anacleto et al., 2007)	(Rolland, 2004)	(Seifert and Jacobitz, 2002)	(Rissato and Romano-Lieber, 2013)	(Cina et al., 2006)	(Costa et al., 2008)	(Anto et al., 2010)	(Bohand et al., 2009a)
Content errors	Wrong medicine dispensed	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Wrong Drug strength dispensed	X	X	X	X	X	X	X	X		X	X		X	
	Wrong dosage-form dispensed	X		X		X	X				X	X	X	X	X
	Expired medicine dispensed			X											X
	Omission of item	X		X	X		X	X			X		X		X
	Wrong quantity dispensed		X		X	X	X					X	X		
	Other content error	X		X	X				X		X		X		
Labelling errors	Wrong patient name		X	X		X	X						X		
	Wrong medicine name					X				X					
	Wrong medicine strength					X							X		
	Wrong frequency														
	Wrong dosage-form									X					
	Wrong date														
	Wrong instructions			X			X			X					
	Completely wrong label														
	Incomplete information														
	Other labelling error		X	X		X	X	X					X		
Other error										X			X		

X denotes inclusion in selected studies.

2.3.6 Potential risk of dispensing errors

In the reviewed studies, various categories were employed to evaluate the potential risks of dispensing errors. Six identified studies (Bohand et al., 2009b, Cina et al., 2006, Irwin et al., 2011, James et al., 2008, James et al., 2011b, Rolland, 2004) assessed the potential risks of dispensing errors. Some of studies (Bohand et al., 2009b, James et al., 2008, James et al., 2011b) depend on professional healthcare worker to assess the severity the dispensing errors for the validity. James et al (2011b) and James et al. (2008) studies depended on risk matrix from London Specialist Pharmacist Group to assess identified dispensing errors. In Rolland studies (2004) dispensing errors assessed by the researcher depend on medication errors classification developed by NCCMERP. While Irwin et al. (2011) presented the severity of the dispensing errors as it reported the healthcare professionals who fill the incident report.

The majority of the dispensing errors in reviewed papers were of minor clinical significance, or caused no harm. Table 2.4 shows the severity rate in these studies. However, some cases were serious and could have caused death; for example, a pharmacist dispensed an incorrect dose of verapamil, 240 mg instead 40 mg, to an 86-year old woman (Bohand et al., 2009b).

Table 2.4: Severity rate in the reviewed studies

References / severity	(James et al., 2011b)	(James et al., 2008)	(Rolland, 2004)	(Irwin et al., 2011)	(Bohand et al., 2009b)	(Cina et al., 2006)
No risk	65%	53%	-	-	-	-
Minor risk	9%	17%	30%	87%	45%	63.8%
Moderate risk	13%	22%	21%	12.6%	29.2%	33.9%
Major risk	9%	5%	2%	0.6%	16.6%	2.2%
Catastrophic	0	1%	-	-	-	-

2.3.7 Factors associated with dispensing errors

Only five identified published studies discuss contributing factors associated with dispensing errors (Anto et al., 2010, Beso et al., 2005, Irwin et al., 2011, James et al., 2008, James et al., 2011b). The three of these studies (Irwin et al., 2011, James et al., 2008, James et al., 2011b) gathered the contributed factors from the incident

reports, while two studies (Anto et al., 2010, Beso et al., 2005) gathered the contributed factors through conducted interviews with the dispensary team. The contributed factors are associated with four main categories; work environment, product, dispensary team and task. The most commonly dispensing errors factors that associated with work environment are high workload, low staff numbers and distract the staff during the dispensing process. Look-alike/sound-alike drugs names and similarity packaging of the medicines are the most common dispensing errors that associated with the product (medicines). The most common contributed factors that associated with dispensary staff's are lack of knowledge/experience and hurrying through tasks. Finally, the there are several dispensing errors factors associated with the task including complex prescription and illegible handwriting. More contributing factors are presented in Table 2.5.

Table 2.5: Dispensing error contributed factors

	Contributed factors / Reference	James et al., (2011b)	Irwin et al., 2011	James et al., (2008)	Beso et al., (2005)	Anto et al., (2010)
Work environment	High workload	70	29	141	22	**X**
	Low staffing	38	14	74	13	**X**
	Distraction/interruption	30	11		14	**X**
	Noise		2			
	Protocols not followed		11		2	
	Dispensary design				4	
	Lone worker	9		10		
	Time of day	29				**X**
Product	Look-alike/sound-alike drug name	37	30	233	9	
	Similarity packaging		3			
	Poor labelling by manufactor		2			
Team	Inexperienced staff	73	26	114	7	**X**
	Communication problem	6		43	1	
	Loss of concentration/fatigue		2		12	
	Low moral				2	
	Urgent deadline/Hurrying through tasks	22	4	49	12	**X**
Task	Complex prescription	6		2		
	Illegible handwriting		4			**X**
	Careless checking		14			
	Unfamiliarity with task		9		5	
	Patient demanding/aggression		5			

The numbers denote how many times these contributing factors had been reported in the study
X denote an indication of contributing factors but without numbers of reported incidents

2.4 Discussion

Identifying types of dispensing errors and factors contributing to these errors are the first step in drawing up strategies to reduce such occurrences. The aim of this study was to review studies conducted in hospital pharmacies to identify the incidence and/or types and/or factors contributing to the occurrence of dispensing errors. To the best of the researchers knowledge, no previous systematic review has focused on dispensing errors in hospital pharmacies only. This systematic review identified fifteen studies carried out in just four different countries. The majority of these studies focused on dispensing error types only, and few studies analysed the severity of the errors, the contributing factors or the strategies used to reduce dispensing errors.

Retrospective and prospective approaches were used to identify dispensing errors on the selected studies. The major difference between the retrospective approach and perspective approach is that with the retrospective, the outcome has already happened, by the time of study design while, the prospective the outcome has not occurred when the study begins (Mangal and Mangal, 2013). Reviewing incident reports retrospectively and direct observation methods were the most commonly employed methods of investigating dispensing errors. All of the Brazilian and French studies used the observational method, while the majority of the UK studies used incident reports. This suggests that reporting on medication errors in the UK is a more common and organised practice. The National Reporting and Learning System (NRLS) began recording such incidents in 2004 (NPSA, 2005). The NRLS help to provide rich data regarding received medication error reports, which it contributes to decrease medication errors through identify the nature and cause of medication errors. However, reporting dispensing errors and near-miss errors is an important strategy to build a safety culture by learning from the errors, so implementing a non-punitive environment is important to encourage the healthcare worker to report the errors (Brady, 2013).

In the identified published studies, a multitude of definitions are provided, all of which agree that a dispensing error is a 'discrepancy between the prescription and dispensed medicines,' though some studies add that it can also mean a 'discrepancy between the modification made by a pharmacist to the prescription and dispensed medicines'. However, some selected studies do not define the term 'dispensing error'. This raises certain questions for the researcher; for instance, whether the errors discussed in those studies include those made by nurses when dispensing medicines in a ward environment. The definition of dispensing error is important to direct the medication safety interested there the errors occur. However, Franklin and O'Grady (2007) have developed a comprehensive and valid definition for a dispensing error. They defined dispensing error as *"any unintended deviation from an interpretable written prescription or medication order including content and labelling errors; any unintended deviation from professional or regulatory references, or guidelines affecting dispensing procedures, is also considered a dispensing error".*

It was observed that the rates of dispensing errors are reported in all studies that used the observation method, and that the rates of these are relatively high. By contrast, just two studies that employed a review of incident reports, report the rate of dispensing errors; the rates are not presented in other studies usually because the total number of dispensed items is unknown. The rate of dispensing errors reported in the selected Brazilian studies (Anacleto et al., 2005, Bonifacio Neto et al., 2013, Costa et al., 2008) was very high (11.5%–33.5%), compared with other selected studies in the UK, the USA and France (3.6%–0.016%). This variation in dispensing error rate might be due to differences in the dispensing system, research methods or the dispensing error classification used in the Brazilian studies (Rissato and Romano-Lieber, 2013). For example, in one Brazilian study (Bonifacio Neto et al., 2013) used categorise dispensing errors according their classification. As result, approximately 87% of the dispensing errors were related to dispensed medicine, with no description of the dosage form. This type of dispensing error is not present in the categories included in other studies.

The most common error types reported in the selected studies are: dispensing the wrong drug, dispensing the wrong strength, dispensing the wrong quantity and omission of items. Omitted dose is the most common dispensing error type in these studies focused on identifying error in the dispensed items for in-patients (unit dose) (Anacleto et al., 2005, Bohand et al., 2009b, Costa et al., 2008, Rissato and Romano-Lieber, 2013). However, various categories are employed in the selected studies to classify the types of dispensing errors. Beso et al. (2005) have developed the most comprehensive classification to categorise dispensing errors, which includes content errors and labelling errors. Two reviewed studies (Costa et al., 2008, Irwin et al., 2011) applied that classification. The others studies (Bohand et al., 2009a, Bohand et al., 2009b, Bonifacio Neto et al., 2013, Cina et al., 2006, Rissato and Romano-Lieber, 2013) focus on content errors and do not consider labelling errors such as incorrect medicine name and wrong patient name. This may be because these studies focus on identifying dispensing errors in unit dose systems; however, labelling errors can have severe risks, for instance, a label with the wrong patient name might cause medicine to be given to the wrong patient.

One of the most effective strategies to improve the patient safety is identifying the contributing factors that associated with the errors. The most common contributing factors identified in the reviewed studies are: look-alikes/sound-alikes, high workloads, low staff numbers, inexperienced staff and rushing to complete tasks. These contributing factors had been reported also on the other medication errors studies such as prescribing and administration errors studies (Alsulami et al., 2013, Ghaleb et al., 2006). However, only five of the selected studies discuss contributing factors; three studies (Irwin et al., 2011, James et al., 2008, James et al., 2011b) gathered information about contributing factors from incident reports, and two studies (Anto et al., 2010, Beso et al., 2005) did the same by interviewing dispensary teams to discover the contributing factors. However, none of the selected studies relied on observation to uncover contributing factors.

These results indicate certain limitations in the methods employed to investigate dispensing errors. For example, the incident report approach does not provide a rate of incident occurrence, and so the total number of reported dispensing errors is uncertain, as some errors were not indicated, or indicated but not reported (James et al., 2011b). In addition, some of the incident reports did not indicate contributing factors. By contrast, all of the observation studies reported the exact incident rate, but no information was given about contributing factors. While qualitative methods, such as interviews, provided an insight into contributing factors, these studies failed to investigate the types of dispensing errors. In order to resolve these limitations, a mixed methods approach is required for use in future studies if they are to investigate both the type of error and contributing factors; the existing studies that utilised a mixed methods approach provided more and accurate details regarding the nature of errors and the contributing factors (Ashcroft et al., 2015, Beso et al., 2005). The unique contribution of combination method research is that it allows for the integration of results from more than one component of a study (Protheroe et al., 2007).

Finally, investigating dispensing error types and contributing factors in the hospital pharmacies is very useful to set strategies to improve patient safety. However, the Institute for Safe Medication Practices (ISMP)(Practices, 2002) recommend some strategies to reduce dispensing errors that are linked to medicines with similar names such as storing medicines with similar names in different locations and distinguishing the similar medicine names by colouring the font or/and using tall-man letter. The NPSA published a guideline booklet (NPSA, 2007a) which aims to minimise the contributing factors through well-designed pharmacies. Moreover, educating the dispensary team about the observed errors in order to avoid future errors can be an effective strategy to enhance the patient safety (Bohand et al., 2009b).

2.5 Conclusion

The published studies that have investigated dispensing errors in the hospital pharmacies. This review identified just fifteen studies conducted in hospital pharmacies. The majority of these studies focus on investigating the types of dispensing errors, and few discussed the factors contributing to these or the strategies used to reduce dispensing errors. All these studies were four countries; UK, Brazil, France and USA. The majority of these studies were lied on review the incident reports retrospectively and observation methods to investigate the dispensing errors. The results of this review highlight the rate of dispensing errors in the hospital pharmacies was between 0.0147% and 33.5%. The variation in dispensing error rate might be due to differences in the dispensing system, research methods or the dispensing error classification. For example, the majority of the studies that conducted in UK depend on review the incident report that reported in the hospital pharmacies and the dispensing errors rate in these studies were low (0.0147% to 2.7%). While the dispensing errors rate in studies Brazilian studies were high (11.5% to 33.5%), where these studies depend on the observation methods to identify the dispensing errors in unit-dose system. Dispensing the wrong medicine and dispense the wrong strength are the most common dispensing error types in the reviewed studies. Some of these studies raised the contributing factors that associated with the dispensing errors and these include high workload, low staff numbers, look-alike/sound-alike drugs and dispensary staff's lack of knowledge/experience. Future studies investigating dispensing errors should use a mixed methods approach to investigate the contributing factors associated with dispensing errors and to explore the strategies employed to reduce these errors.

Chapter 3: Overall Methodology and Theoretical Framework

3.1 Theoretical framework

Creswell (2009) presented three framework elements involved in research design. The first element is the claim to knowledge the researcher is making. The second element is the strategies of inquiry that will inform the procedure. The final element is the method of data collection and analysis.

Knowledge claim refers to the theoretical perspectives or beliefs that underlie the research and may also be called paradigms or philosophical assumptions. Creswell et al. (2009) recognised four main paradigms: postpositivism, social constructivism, advocacy/participatory, and pragmatism. The first paradigm, postpositivism, is usually associated with quantitative research that is characterised by deductive reasoning, careful observation and hypothesis testing. The second paradigm, social constructivism, is usually associated with qualitative research, and it relies on the participants' own views and experience to articulate their world (Mackenzie and Knipe, 2006). The advocacy/participatory paradigm is driven by a desire to improve society and by political concerns; the researcher aims to bring about positive changes in the social world. The fourth paradigm, pragmatism, usually focuses on actions, situations and consequences by using a combination of qualitative and quantitative methods, and the researcher is concerned more with what works and what approach will suit the condition or solve the problem.

The second and the third elements of the research design framework are strategies of inquiry and the research methods used to collect and analyse the data. Strategies of inquiry are classified into three groups depending on the methodology of the approach. The first group is associated with a quantitative approach such as experiments and surveys. The second group is associated with a qualitative approach and involves case studies, ethnography, phenomenology research and narrative study (Creswell, 2003). The third group is associated with the mixed methods

approach (quantitative and qualitative methods) and involves four main types of design methods: triangulation, embedded, explanatory and exploratory designs (Tashakkori and Teddlie, 2010, Creswell, 2009). Table 3.1 gives an overview of these approaches.

Table 3.1: Overview of quantitative, qualitative, and mixed methods approaches (Creswell, 2013)

	Quantitative	Qualitative	Mixed-methods
Paradigms	Postpositivism knowledge claims	Constructivism or participatory knowledge claims	Pragmatic knowledge claims
Methods	Close-ended questions, pre-determined approaches, numeric data	Open-ended questions, emerging approaches, text or image data	Both close- and open-ended questions, both pre-determined and emerging approaches, and both quantitative and qualitative data analysis
Research practices	- Tests or verifies theories or explanations - Identifies variables of interest - Related variables in questions or hypothesis - Uses standards of reliability and validity - Employs statistical procedures	- Discovered the experiences and perspectives of participants - Focuses on a single concept or phenomenon - Studies the context or setting of participants - Validates the accuracy of findings interprets the data	- collects both quantitative and qualitative data - Develops a rational for mixing - Integrates the data at various stages of inquiry - Employs he practices of both quantitative and qualitative

In triangulation design, the researcher usually utilises qualitative and quantitative methods at the same time rather than using the qualitative and then the quantitative data to answer the research questions (Matthews and Kostelis, 2011, Hanson et al., 2005). In the embedded design, the researcher collects and analyses quantitative data within a qualitative research design (or vice versa). In the explanatory design, the researcher begins to collect and analyse the quantitative data then he/she collects and analyses qualitative data (Matthews and Kostelis, 2011). While in the exploratory design, the researcher starts to collect and analyse the qualitative data then he/she collects and analyses quantitative data.

One of the main objectives of this study is to investigate the factors associated with dispensing errors in pharmacies and how to reduce these errors. A combination of a qualitative and quantitative approach was applied to achieve this aim. These methods use generalised and in-depth data about the issue, this type of paradigm known as pragmatism framework as described previously (page 49). Explanatory mixed design was utilised in this study. The quantitative method used first to identify the dispensing errors types. Next, the qualitative approach used to investigate perceptions and opinions of the dispensary team about factors associated with dispensing errors and ways to reduce these errors.

The major methods for detecting medication error and ADEs are chart review, incident reporting, computerised monitoring, direct observation, questionnaires and interviews the healthcare staff (Montesi and Lechi, 2009, Cohen, 2007). Of these methods, chart review, incident reporting and direct observation represent some of the most common methods of identifying medication errors (Montesi and Lechi, 2009). However, healthcare manager and researchers most commonly investigate dispensing errors by reviewing incident reporting at hospitals and by observing the dispensary team during the dispensing process (James et al., 2009). The previous chapter (systematic review) indicated that studies using direct observation (Anacleto et al., 2005, Bohand et al., 2009b, Cina et al., 2006, Costa et al., 2008) did not provide information about the contributing factors associated with dispensing errors. The direct observation method is one of the best methods to investigate dispensing errors but it has a number of limitations, notably the influence of the observer on the behaviour of the dispensary team (Hawthorne effect) (James et al., 2009). Direct observation is also costly and time-consuming (Flynn et al., 2002). Thus, reviewing the incident reports represents a suitable alternative for investigating dispensing errors in a cost-efficient manner (Flynn et al., 2002). However, direct observation and incident reports fail to provide in-depth information about the contributing factors; they are also unable to provide strategies that reduce dispensing errors. As a result, companies need to complement these methods with alternatives if they aim to investigate the contributing factors and generate strategies to reduce errors.

Qualitative methods provide deep, rich information, so they are useful in exploring how patient safety incidents occur with healthcare staff (Fein et al., 2005). Focus groups, interviews and open-ended questionnaires are the most common qualitative methods used in medication errors studies (Al Hamid et al., 2014, Keers et al., 2013). Self-administered questionnaires are characterised by their affordability and ability to quickly collect a great deal of information anonymously (Mitchell and Jolley, 2012). Researchers have used self-administered questionnaires to investigate healthcare staff perceptions about contributing factors to medication errors and/or the strategies to reduce such mistakes (Al-Shara, 2011, Petrova, 2010, Mary Fry and Dacey, 2007, Teinilä et al., 2011, Kim et al., 2011, Shahrokhi et al., 2013, Oshikoya et al., 2013).

One of the benefits of applying a combination of quantitative and qualitative methods to achieve specific aims and objectives are well recognised (Smith, 2005). Quantitative methods are useful mapping devices as they allow the researcher to collect a small and definite amount of data from a large sample of the target population. On the other hand, qualitative questionnaires are very useful for exploratory work, and they can help to determine causal relationships (Kane, 2004). When one research approach, either quantitative or qualitative, is inadequate to answer research questions, a combined method may be helpful to understand the research problems (Creswell, 2013). Table 3.2 shows a summary of the justification for using a combination of methods in the context of each research question.

Table 3.2: Justification for research methods used

Questions	Methodology	Method	Rationalisation
What types of dispensing errors are reported in pharmacies at King Saud Medical City (KSMC) hospital in KSA, and at Luton and Dunstable University Hospital (L&D) NHS Foundation Trust in the UK?	Quantitative	Retrospective review of incident reports	A retrospective method such as incident reports review can be utilised to identify the occurrence of errors and to facilitate learning (Acton, 2012).
What is the severity of the identified and reported dispensing errors in pharmacies at Medical City (KSMC) in KSA, and at L&D Hospital in the UK?	Quantitative	Retrospective review of incident reports and expert panel assessment by used Delphi survey technique	This method is useful to combine different experts' opinions in order to obtain a consensus assessment for such cases.
What are the perceptions of the dispensary team about the contributing factors to dispensing errors?	Qualitative	Self-administered qualitative questionnaires (open-ended questions)	Qualitative questionnaires are very useful for exploratory work, and can help to determine causal relationships (Kane, 2004).
What are the perceptions of the dispensary team about ways of reducing dispensing errors?	Qualitative	Self-administered qualitative questionnaires (open-ended questions)	Open-ended questions offer a means of obtaining detailed data from a specific target population in a shorter period of time and at less cost than face-to-face interviews (O'Hara, 2011).

3.2 Method

3.2.1 Study sites

3.2.1.1 King Saud Medical City (KSMC)

The Ministry of Health is the major provider of healthcare in Saud Arabia, through the primary, secondary and tertiary care avenues. King Saud Medical City (KSMC) which is located in the capital of KSA (Riyadh) is one of the oldest and largest MOH healthcare institutions. The Medical City has 1,200 beds and an additional 140 beds in intensive-care units. Moreover, there are also specialist clinics for non-admitted patients in out-patients clinics.

3.2.1.2 Luton and Dunstable University Hospital NHS Foundation Trust

Luton and Dunstable University Hospital (L&D) NHS Foundation Trust is a medium-sized general hospital (600 beds) that is located in Bedfordshire, in the north of London. L&D hospital was established in 1939. Currently, L&D hospital is run by the NHS and it is provides general healthcare services for over 350,000 people in Luton and Dunstable, the south of Bedfordshire, the north of Hertfordshire and parts of Buckinghamshire. In 2009, the hospital was awarded 'Best in Class' for combating healthcare-acquired infections such as *C. diff* and MRSA. The hospital was nominated for the award by the NHS East of England Strategic Health Authority (L&D, 2009).

3.2.2 Study Design

The research consists of three phases (Figure 3.1) as follows: Phase 1: A systematic review of published studies exploring the incidence and types of dispensing errors in hospital pharmacies. Phase 2: Identification of types of dispensing errors and assessing their severity. This phase was undertaken through retrospective review of incident reports in the two hospitals and then the identified dispensing errors assessed by an expert panel of three clinical pharmacists. Phase 3: Investigation of perceived factors contributing to dispensing errors and how to reduce these errors. In this phase, self-administered qualitative questionnaires applied to collect more detailed data from the dispensary team to obtain their perceptions and opinions about dispensing errors and how to reduce these errors.

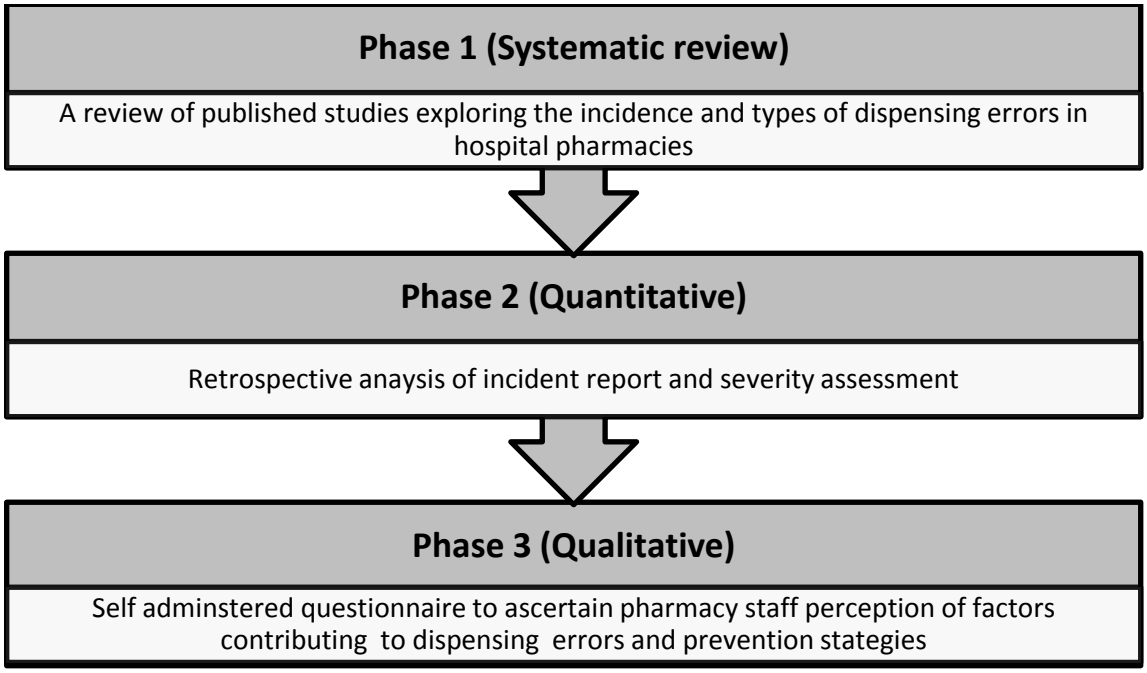

Figure 3.1: Flowchart of research methods

3.3 Ethics approval

Ethical approval required for this study was obtained from the University of Hertfordshire Research Ethics Committee (REC) (LMS/PG/UH/00086) (appendix 1) and King Saud Medical City hospital Research Ethics Committee (appendix 2). Approval was obtained from the pharmacy manager at Luton and Dunstable Hospital NHS Foundation Trust (appendix 3). Ethical approval was not required by the NHS REC.

3.4 Funding

This research was being organised by the University of Hertfordshire and funded through a PhD student grant from the Royal Embassy of KSA.

Chapter 4: The nature of dispensing errors in KSMC and L&D

4.1 Introduction

Identifying and understanding the nature of errors is essential strategy to improve patient safety (Barton, 2009). Different types of medication errors can occur while dispensing medicines in hospital pharmacies, and the nature of these errors may vary from hospital to hospital, due to the implemented dispensing system and the facilities available. For example, dispensing the wrong medicine has been reported as the most common type of dispensing error in some hospital pharmacies (Roberts et al., 2002, Cina et al., 2006), while omitting the dose has been reported as a common type of dispensing error in other hospital pharmacies that have unit dose system (Rissato and Romano-Lieber, 2013, Beso et al., 2005, Anacleto et al., 2007). Furthermore, Bonifacio Neto et al. (2013) reported that about 87% of the dispensing errors in a Brazilian hospital were related to the dosage form.

The assessment of medication error severity is an essential concept in patient safety (NPSA, 2007b). The aim of assessing dispensing error severity is to help the healthcare institution track medication errors in a consistent and systematic manner (NCCMERP, 2012). The main objectives of this phase of the research were:

- To retrospectively identify the types and nature of medication errors reported in KSMC and L&D hospitals
- To retrospectively identify the types and nature of dispensing errors reported in KSMC and L&D hospital pharmacies
- To investigate the severity of unprevented dispensing errors, which are detected and reported following the completion of the dispensing process (medicines that have left the pharmacy department)

4.2 Method

4.2.1 Definition of dispensing errors

A multitude of definitions are provided in the published studies. Franklin and O'Grady (2007) have the most comprehensive and valid definition for a dispensing error. That definition formulated by an expert panel (20 members) through the Delphi technique. Franklin and O'Grady defined dispensing error as *"any unintended deviation from an interpretable written prescription or medication order including content and labelling errors; any unintended deviation from professional or regulatory references, or guidelines affecting dispensing procedures, is also considered a dispensing error"* (Franklin and O'Grady, 2007). This definition applied to identify dispensing errors in this study.

4.2.2 Classification of dispensing errors

Dispensing errors were classified in this study according to the coding framework developed by Beso et. al, (2005), as shown in Table 4.1. Various classification are employed in the previous studies to classify the types of dispensing errors. Beso et al. (2005) have developed the most comprehensive classification to categorise dispensing errors in pharmacies. That categories cover all the types of dispensing errors. Several researcher depended on this classification to categorise dispensing errors in the hospital pharmacies (Costa et al., 2008, Irwin et al., 2011).

Table 4.1: Categories of dispensing error adopted from Beso et al. (2005)

Content errors	Labelling errors
Dispensing the wrong medicine Dispensing the wrong drug strength Dispensing the wrong dosage form Dispensing an expired medicine Omission of item Dispensing the wrong quantity - Missing doses - Adding doses	Wrong patient name Wrong medicine name Wrong medicine strength Wrong frequency Wrong dosage form Wrong date Wrong instructions Completely wrong label Incomplete information in the label

4.2.3 Data collection

A retrospective review of dispensing error reports for an 18-month period from January 1, 2012 to June 30, 2013 was conducted. These reports were accessed from the Drug and Poison Information Centre in the pharmacy department at KSMC as hard copies (the medication error report form is shown in appendix 4). For L&D Hospital, the risk management department gave the researcher authority to access medication errors reports using the Datix Software (a blank form is shown in appendix 5). The medication errors forms in both hospitals have the same components, which are as the following:

- Incident date
- Incident time
- Report date
- The medicine involved in the incident (medicine name, dose, dosage form and route of administration)
- location of incident
- Type of incident; Prescribing, dispensing …etc.
- Description of incident
- Incident severity
- Action taken
- Reporter detail
- Who did the error; physician, pharmacist, nurse...etc. (KSMC only)

For the purposes of collecting the data required to complete this research study, two data collection forms were developed. The first form is the Medication Errors Data Collection Form (appendix 6) to collect all medication error required data. The required data in this form includes; incident date, medicine involved in the incident details (name, strength, dose and dosage form), type of errors (prescribing, dispensing, administration, transcribing or monitoring) and incident description. The incident description section used to write more details about the incident such as if the patient had the medicine or not. The second form is Dispensing error Data Collection Form (appendix 7). This form is specific to collect the dispensing error

detail. This form had an extra requirement detail which is description of the dispensing errors such as dispense the wrong medicine or strength and labelling the incorrect medicine name.

For data collection validity purposes, a considered percentage (10%) of both medication and dispensing errors were selected randomly (computer generated) to be checked by expert pharmacists, the KSMC incidents was checked by the medication safety officer in KSMC and the L&D incidents was checked by the supervisor (Dr. Umaru). Levels of agreement between the researcher and the reviews in the classified the errors were assessed by Cohen's Kappa coefficient, which is designed to assess the percent-agreement estimate by considering the amount of expected agreement that could occur by chance (Bryman and Cramer, 2005). The Kappa statistic is useful when there is concern about artificially inflated percent-agreements. By convention, a Kappa of <0.2 is considered poor agreement, 0.21-0.4 fair, 0.41-0.6 moderate, 0.61-0.8 good, and 0.8 – 1.0 very good agreement (Landis and Koch, 1977a, Landis and Koch, 1977b).

4.2.5 Data analysis

Data was entered into a Statistical Package for the Social Sciences (SPSS) (version 20) spreadsheet for analysis, and comparisons were made between the two hospitals. Descriptive statistics were applied in order to examine the dispensing error incident reports collected from the two hospitals. A Fisher's exact test (2X2) was used to compare the main dispensing error incidents frequency (content and labelling) between the two hospitals (two by two crosstable). Fisher's test is the best choice to compare two groups with two outcomes (two by two crosstable) as it gives the exact P-value, while the chi-square test calculates the approximate P-value (Jaykaran, 2011). A P-value of equal or less than to 0.05 was considered statistically significant.

4.2.6 Assessment of dispensing errors clinical significance

This phase of the research involved assessing the clinical significance of unprevented dispensing errors that were identified in KSMC and L&D hospitals. Assessment forms describing all unprevented dispensing errors were sent to an expert panel consisting of three clinical pharmacists (two currently working as the patient safety pharmacist in their respective hospitals), to assess the potential risk of patient harm. . The expert panel members were asked to rate the unprevented dispensing errors' scenarios, and classify them for potential risk of patient harm, using the classification description provided in Table 4.2, which was used in the study by James at el. (2011) which adopted from the London Specialist Pharmacist Group. The mode rate (most frequent answer) was taken in case there was variety in the reviewers' answer. However, the levels of agreement were assessed by Cohen's Kappa coefficient. The Assessment of Dispensing Error Severity Form contains the dispensing error reference number, the prescribed medicine, a description of the error, the level of potential risk and a justification for the potential risk level (appendix 8).

Table 4.2: Risk matrix for classifying the clinical significance of dispensing errors

Potential risk level	Description of dispensing errors
Catastrophic	This could have resulted in death.
Major	These could have caused major permanent harm or an increased length of stay in hospital or increased level of care for more than 15 days.
Moderate	These incidents could have caused semi-permanent harm (up to 1 year) or an increased length of stay in hospital or increased level of care for up to 15 days.
Minor	This includes incidents that could have resulted in non-permanent harm (up to 1 month) or an increased length of stay in hospital or increased level of care for up to 7 days
None	No harm could have resulted.

4.3 Results

This section describes the finding about medication errors and dispensing errors reported in KSMC and L&D hospitals. The difference in dispensing errors between KSMC and L&D hospitals is also presented.

4.3.1 Medication errors

4.3.1.1 Medication errors in KSMC

The total number of reported incidents associated with medication errors in KSMC from January 1, 2012 to June 30, 2013 was 6,101 incidents of 1,571,975 prescribed medicines (rate of medication errors0 0.38%). Results of an analysis of medication incident reports by stage of the medication process are shown in Table 4.3. The majority of the errors (n= 4,561, 74.8%) occurred during the transcribing stage. Incidents associated with prescribing were reported 774 times (12.7%) while 637 incidents (10.4%) occurred at the dispensing stage. About 2% of medication errors were associated with monitoring (1.4%) and administration (0.7%). To validate the medication errors classification, 5% (n= 323) of the data were independently classified by a qualified pharmacist with experience in medication errors (patient safety officer in KSMC). Cohen's Kappa coefficient was 0.82 which is in agreement with the decisions made by both the researcher and the pharmacist regarding medication error.

Table 4.3: Frequency of dispensing errors according to the type of medication errors in KSMC

Type of Medication Error	Frequency & Percent (%)	Examples
Transcribing	4561 (74.8%)	- Transcribed the wrong dose for enoxaparin dose (4 mg instead of 40 mg) - Transcribed Metronidazole 500 mg instead of Metformin 500 mg - Transcribed the wrong frequency for Cefuroxime 500 mg (three times daily instead of twice daily) - Transcribed the wrong duration for Ciprofloxacin oral (5 months instead of 5 days) - Dose of Insulin not transcribed
Prescribing	774 (12.7%)	-Prescribed the wrong frequency for Amlodipine (twice daily instead of one tine daily) -Prescribed the wrong duration for Warfarin (7 days), the policy duration is one day only for the in-patent -Prescribed Esomeprazole and Ranitidine (both have same effect) -Prescribed the wrong duration for Cephalexin (3 days instead of 10 days)
Dispensing	637 (10.4%)	-Dispensed wrong dosage form for Mesalamine (rectal suppository instated of oral tablet) -Dispensed and labelled wrong dose for Carvedilol (12.5 mg instead of 25 mg) -Dispensed wrong medicine (Pregabalin 75 mg instead of Clopidogrel 75 mg)
Monitoring	86 (1.4%)	- The clinical pharmacist recommend to increase the warfarin dose to 7mg instead of 5mg because the level was below the range but the dose was not changed - The patient given Amikacin while the patient was still on Vancomycin
Administration	43 (0.7%)	- Omission error (Gentamicin dose was not given to the patient) - Unprescribed medicine given to the patient (Vancomycin) - Administered Labetalol in the wrong time
Total	6101 (100%)	

Figure 4.1 shows the frequency of incidents for each month from the period of January 2012 to June 2013. There was a significant difference between the rates of medication errors that reported in each month. More medication errors were reported in 2013 compared to 2012 (4,045 and 2,056 respectively). The smallest number of medication errors occurred in March 2012 (73 incidents) while the largest number was in April 2013 (1,244 incidents). The number of medication errors in the months between June to November 2012 remains relatively small, ranging from 73-

224 medications errors. However, medications errors rise to 414 in December 2012. In January 2013, 322 medication errors were reported and about 600 errors occurred in February. In May 2013, 943 errors were reported, yet the number of errors decreased significantly to 226 errors in June 2013.

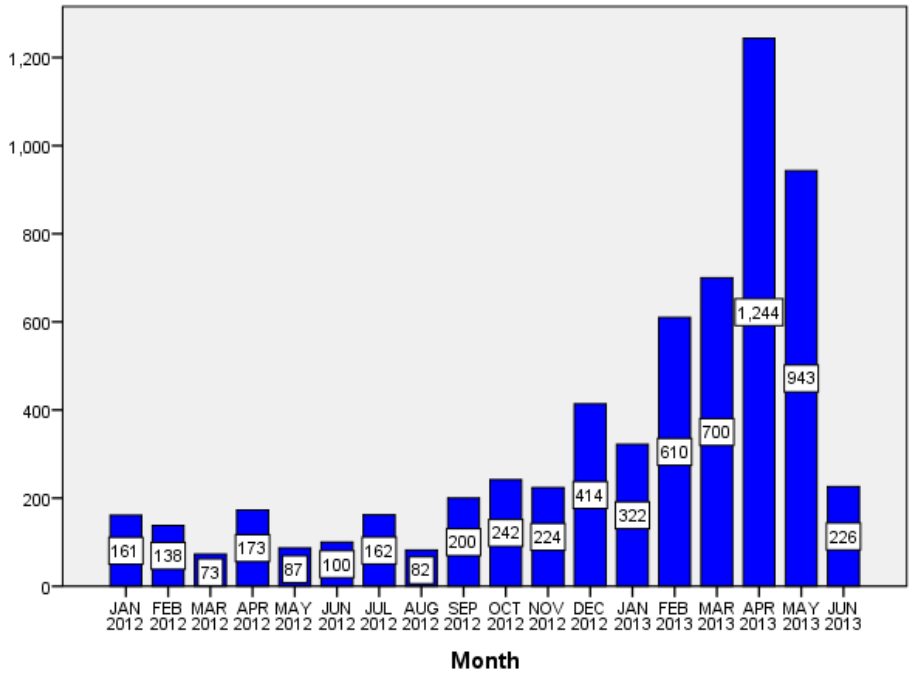

Figure 4.1: Distribution of medication errors for each month in KSMC

Figure 4.2 outlines the percentage (%) of incidents in KSMC according to the day of the week. The percentage of incident reports was lowest during weekend days Thursday (13.13%) and Friday (10.03%), while the maximum percentage of dispensing errors occurred on Wednesday (18.19%).

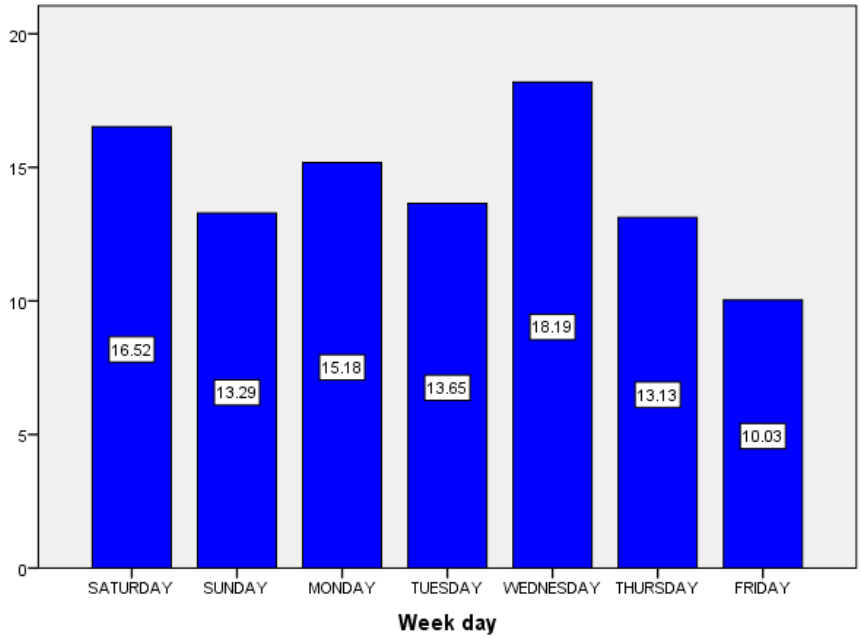

Figure 4.2: Percentage of medication errors reported for each day of the week in KSMC

Table 4.4 outlines the percentages of medication errors based on the classes of drugs (according to BNF V.65 classification). Anti-infective and cardiovascular agents were the most common medicines involved in medication errors (1,443; 23.7% and 1,387; 22.6% respectively), followed by nutritional products (750, 12.3%), gastrointestinal agent medications (620, 10.2%), gastrointestinal agents (620, 10.2%) and central nervous system agents (604, 9.9%). The most common medicines involved in medication errors were Paracetamol (n=284, 4.5%), Omeprazole (n=280, 5.4%), Cefuroxime (n=129, 2.1%) and Augmentin (n=199, 3.2%). These medicines are common prescribed in the hospital but the prescribed numbers for these medicines unavailable. Medicines with narrow therapeutic index reported several times such as Warfarin (n=112) and Gentamicin (n=35). Also, Amiloride and Aminophylline reported several times and these medicines classified by NPSA in the BNF (V.65) as high risk medicines.

Table 4.4: Medications involved in medication errors reported at KSMC (BNF V.65)

Medicine class	Frequency					
	Transcribing	Prescribing	Dispensing	Monitoring	Administration	Total
Infection	1016	282	120	16	16	1443 (23.7%)
Cardiovascular system	1049	144	150	35	7	1387 (22.7%)
Nutritional and blood	604	56	53	16	8	750 (12.3%)
Gastro-intestinal system	486	86	27	0	3	620 (10.2%)
Central nervous system	475	44	82	5	4	604 (9.9%)
Endocrine system	307	53	95	4	3	435 (7.1%)
Musculoskeletal and joint diseases	257	18	16	2	1	297 (4.9%)
Respiratory system	195	59	29	0	0	289 (4.7%)
Skin	57	10	32	0	0	96 (1.6%)
Eye	46	7	16	1	0	79 (1.3%)
Malignant disease and immunosuppression	23	2	6	0	0	30 (0.5%)
Ear, nose and oropharynx	21	4	5	0	0	29 (0.5%)
Immunology products and vaccines	11	7	6	0	1	24 (0.4%)
Anaesthesia	6	0	0	0	0	10 (0.2%)
Emergency treatment of poisoning (Antidote)	5	2	0	1	0	8 (0.1%)
Total	4561	774	737	86	43	6101

4.3.1.2 Medication errors in L&D

The total number of incidents associated with medication errors at the L&D hospital from January 1, 2012 to June 30, 2013 was 766 incidents. Results of an analysis of medication incident reports by stage of the medication process are shown in Table 4.5. The highest incidents (n= 365, 49%) occurred during drug administration. Incidents associated with prescribing were reported 295 times (38.5%) followed by incidents which occurred in the dispensing stage (n= 49, 6.4%). To validate the medication errors classification, 5% (n= 36) of the data was independently classified by a qualified pharmacist with experience in medication safety. Cohen's Kappa coefficient was 0.81 which indicated very good agreement between the researcher and the pharmacist about medication error classification.

Table 4.5: Frequency of dispensing errors according to the types of medication errors in L&D

Type of Medication Error	Frequency & Percent (%)	Examples
Administration	376 (49%)	- Omission error (Gentamicin dose did not give to the patient) - Administered wrong dosage form (Vancomycin IV instead of oral) - Administered wrong frequency (Paracetamol 1 gm IV twice at 12pm) - Administered wrong dose (Bisoprolol 5 mg instead of 1.25 mg)
Prescribing	295 (38.5%)	- Prescribed the wrong frequency for Fentanyl patch (every 7 days instead of every 3 days) - Prescribed the wrong dose for Dexamethasone IV (80 mg twice daily instead of 8 mg twice daily) - Prescribed wrong medicine (Levothyroxine 125 mcg instead of Lamotrigine 150 mg) - Prescribed the wrong combination (Clopidrogrl 75 mg + Enoxaparin 40 mg + Ketorolac 20 mg), all three drugs can increase the risk of bleeding)
Dispensing	49 (6.4%)	- Dispensed Moxonidine 200mcg instead of Moxifloxacin 400mg - Labelling Morphine 5ml instead of Morphine 2.5ml - Dispensed Enoxaparin 40mg instead of Enoxaparin 20mg
Monitoring	36 (4.7%)	- Gentamycin given to a baby without levels being taken - Patient given Vancomycin 750 mg IV and the level was above the normal level
Dispensing by Nurse	6 (0.8%)	- Discharge patient given Medicines from the patient cupboard, all the medicines did not belong the patient
Delivery	3 (0.4%)	- Delay of about one hour to deliver Morphine IV to the emergency department
Counselling	1 (0.1%)	- Patient being discharged on warfarin for the first time and the patient did not receive any counselling
Total	766 (100%)	

Figure 4.3 shows the frequency of medication errors for each month. There was a significant difference between the rates of medication errors that reported in each month. The fewest number of medication errors was in April and July 2012 (26 incidents) while the highest number was in March 2013 (64 incidents).

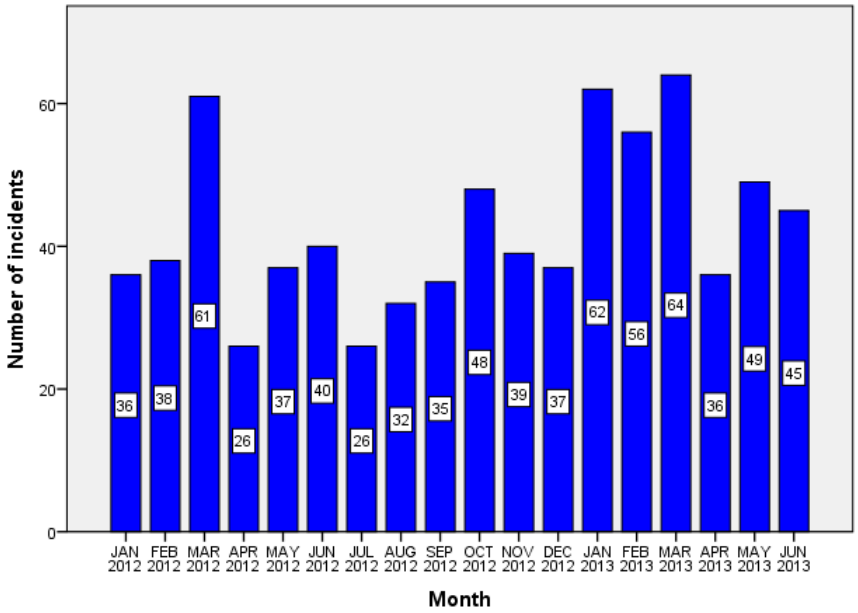

Figure 4.3: Distribution of medication errors for each month in L&D Hospital

Figure 4.4 outlines the number and the percentage (%) of incidents reported in L&D according to the day of the week. There was a significant difference between the rates of medication errors that reported in week days. While, the percentage of reports is lowest during weekend days (Saturday 10.7% and Sunday 9.9%), while the maximum number of medication errors occurred on Wednesday (18.28 %), Friday (16.58%) and Monday (16.32%). The most common medicines involved in medication errors were Insulin (n=64), Enoxaparin (n=38), Paracetamol (n=31) and Warfarin (n=28).

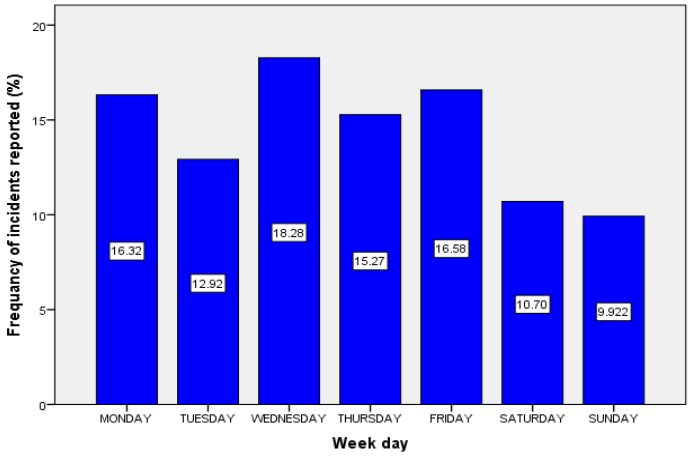

Figure 4.4: Percentage of medication errors reported for each day of the week in L&D

Table 4.6 outlines the frequency of medication errors based on the classes of drugs (according to BNF V.65 classification). Central nervous system agents and cardiovascular agents were the most common medicines involved in medication errors (187 incidents and 152incidents, respectively), followed by anti-infective agents (135 incidents), endocrine system agents (90 incidents) and nutritional products (72 incidents). There are 44 incident did not report the medicines involved in medication errors.

Table 4.6: Medications involved in medication errors in L&D (BNF V.65)

Medicine class	Frequency					
	Prescribing	Dispensing	Administration	Monitoring	Others	Total
Central nervous system	84	14	79	7	3	187
Cardiovascular system	66	4	65	14	3	152
Infection	41	3	82	8	1	135
Endocrine system	33	2	52	2	1	90
Nutritional and blood	21	5	43	1	2	72
Skin	8	4	10	1	0	23
Malignant disease and immunosuppression	4	8	2	0	0	14
Respiratory system	6	2	5	0	0	13
Gastro-intestinal system	5	3	4	0	0	12
Immunology products and vaccines	4	0	4	0	0	8
Musculoskeletal and joint diseases	7	0	0	0	0	7
Anaesthesia	2	0	4	0	0	6
Eye	1	2	0	0	0	3
Missing	23	2	16	3	0	44
Total	295	49	376	36	10	766

4.3.1 Dispensing errors

4.3.1.2 Dispensing errors in KSMC

A total of 617 cases (96.9%) of dispensing errors were intercepted before the medicines left the pharmacy department. However, 20 cases (3.1%) of dispensing errors went undetected before the medicines left the pharmacy. Nurses identified eight incidents of dispensing errors while six incidents were identified by patients and three incidents by physicians. Three errors identified by pharmacists when the patient came to the pharmacy to ask about the medicines. In eight of these cases, the patient had already taken the medicine. Table 4.7 shows the dispensary team staff who were involved in dispensing errors. Of those dispensing errors that were prevented, 74% (*n* = 473) involved pharmacy technicians. Fourteen cases of dispensing errors were detected outside the pharmacy department while pharmacists identified 459 cases prior to leaving the pharmacy department at the final accuracy check. Overall, 26% of the incidents (*n* = 164) occurred with pharmacists. Of these, six cases of dispensing errors were detected outside the pharmacy department while 158 cases were prevented before the medicines left the pharmacy department.

Table 4.7: Numbers and rates of prevented dispensing errors and undetected dispensing errors

Dispensary team	Prevented dispensing errors (n)	Undetected dispensing errors (n)	Total (n)
Technician pharmacist	459 (74.4%)	14 (70%)	473 (75.3%)
Pharmacist	158 (25.6%)	6 (30%)	164 (25.7%)
Total	617	20	637

The number of incidents reported associated with dispensing errors at KSMC from January 1, 2012 to June 30, 2013 was 609 incidents. Twenty-five reports had two incidents and one report had four incidents. The total number of dispensing errors was 637. Table 4.8 shows the frequency of incidents for each month. The smallest

number of all dispensing errors was in May 2012 (6 incidents) while the largest number was in April 2013 (102 incidents).

Table 4.8: Frequency of the dispensing errors for each month at KSMC

Months	Dispensing Errors		
	Prevented	Unprevented	Total
January 2012	19	2	20
February 2012	14	2	16
March 2012	9	0	9
April 2012	19	0	19
May 2012	6	0	6
June 2012	21	0	21
July 2012	27	1	28
August 2012	5	4	9
September 2012	33	1	34
October 2012	19	0	19
November 2012	27	0	27
December 2012	55	0	55
January 2013	24	2	26
February 2013	85	3	88
March 2013	71	1	72
April 2013	102	0	102
May 2013	61	0	61
June 2013	22	4	26
Total	617	20	637

Table 4.9 shows the frequency and the percentage (%) of dispensing errors according to the day of the week. The lowest percentage of reported incidents is on weekend days in KSA (Friday) while the highest percent of dispensing errors occurred on the first day after the weekend (Saturday). High number of unprevented dispensing errors occurred in Saturday, while no unprevented dispensing errors in Sunday.

Table 4.9: Frequency and percentage of dispensing errors reported for each day of the week in KSMC

Weekday	Dispensing Errors		
	Prevented	Unprevented	Total
Saturday	110 (17.8%)	7 (35%)	117 (18.4%)
Sunday	89 (14.4%)	0	89 (14%)
Monday	86 (13.9%)	3 (15%)	89 (14%)
Tuesday	105 (17%)	2 (10%)	107 (16.8%)
Wednesday	81 (13.2%)	2 (10%)	83 (13%)
Thursday	85 (13.8%)	1 (5%)	86 (13.5%)
Friday	63 (10.2%)	3 (15%)	66 (10.3%)
Total	617 (100%)	20 (100%)	637 (100%)

Table 4.10 shows the frequency of dispensing errors according to the type of dispensing error. Most of the errors (*n* = 323, 50.7%) included dispensing the incorrect medicines followed by dispensing the incorrect strength/concentration (*n* = 128, 20.1%). Other commonly occurring errors included medicine labels with an incorrect strength/concentration (*n* = 89, 14%) and dispensing the wrong formulation (*n* = 68, 10.7%). To validate the dispensing errors classification, 5% (n= 35) of the data was independently classified by the pharmacist. The level of agreement between the researcher and the pharmacist was 1 which means there was total agreement on the dispensing error classification.

Table 4.10: Types of dispensing errors reported in KSMC Pharmacy

Type of dispensing error	Prevented dispensing errors	Unprevented dispensing error	All dispensing errors
	Frequency (%)	Frequency (%)	Frequency (%)
Dispensing the wrong medicine	313 (50.7%)	10 (50%)	323 (50.7%)
Dispensing the wrong drug strength	125 (20.3%)	3 (15%)	128 (20.1%)
Labelling the wrong medicine strength	87 (14.1%)	2 (10%)	89 (14%)
Dispensing the wrong formulation	66 (10.7%)	2 (10%)	68 (10.7%)
Dispensing the wrong quantity -adding dose	9 (1.5%)	1 (5%)	10 (1.6%)
Dispensing an expired medicine	6 (0.9%)	1 (5%)	7 (1.1%)
Dispensing the wrong quantity -missing dose	4 (0.6 %)	0	4 (0.6%)
Incomplete information in the label	3 (0.5%)	0	3 (0.5%)
Labelling the wrong instructions	3 (0.5%)	0	3 (0.5%)
Omission of an item	1 (0.16%)	1 (5%)	2 (0.3%)
Total	617 (100%)	20 (100%)	637 (100%)

Table 4.11 shows the class of medicines most commonly involved in dispensing errors were cardiovascular agent drugs (n = 150, 23.5%), followed by anti-infective agent drugs (n = 120, 18.8%), endocrine system agents (n = 95, 14.9%) and central nervous system medications (n = 82, 12.9%). The cardiovascular agent medicine mostly reported with dispensing errors was Furosemide (n= 15). Truvada® (emtricitabine and tenofovir) was the most common anti-infection medicine involved in dispensing errors (n=32). While, Insulin was the endocrine system agent mostly involved in dispensing errors. Insulin on of the medicine that classified as high-alert medicine (ISMp, 2016).

Table 4.11: Medications involved in dispensing errors (BNF V.65)

Medicine class	Prevented dispensing errors	Unprevented dispensing error	All dispensing errors
	Frequency (%)	Frequency (%)	Frequency (%)
Cardiovascular system	145	5 (25%)	150 (23.5%)
Infection	119	1 (5%)	120 (18.8%)
Endocrine system	91	4 (20%)	95 (14.9%)
Central nervous system	80	2 (10%)	82 (12.9%)
Nutritional and blood	50	3 (15%)	53 (8.3%)
Skin	32	0	32 (5%)
Respiratory system	28	1 (5%)	29 (4.6%)
Gastro-intestinal system	25	3 (15%)	27 (4.2%)
Musculoskeletal and joint diseases	16	0	16 (2.5%)
Eye	16	0	16 (2.5%)
Malignant disease and immunosuppression	5	1 (5%)	6 (0.9%)
Immunology products and vaccines	6	0	6 (0.9%)
Ear, nose and oropharynx	5	0	5 (0.8%)
Total	317 (100%)	20 (100%)	637 (100%)

Table 4.12 describes all the unprevented dispensing errors reported in KSMC pharmacy.

Table 4.12: Unprevented dispensing errors reported in KSMC

ID	Dispensing errors
	Dispensing the wrong medicine
1330113 1610213 1700213	Dispensed Methyldopa 250mg instead of Dexamethasone 0.5mg
1960613 1970613	Dispensed Vitalipid instead of Fat emulsion
510112	Dispensed fluticasone+salmeterol inhaler instead of Fluticasone
200212	Dispensed Cefuroxime 750mg vial instead of Vancomycin 500mg vial
1500712	Dispensed Sodium bicarbonate 375mg instead of Calcium carbonate 500mg
620812	Dispensed Perindopril 5mg instead of Prednisolone 5mg
1540112	Dispensed Calcium carbonate 500mg instead of Paracetamol 500mg
	Dispensing the wrong drug strength
430812	Dispensed Nifedipine 10mg instead of Nifedipine 20mg
340812	Dispensed Mesalazine 1gm suppository instead of 500mg for in-patient
270912	Dispensed Simvastatin 10mg instead of Simvastatin 40mg
	Dispensing the wrong formulation
3140113	Dispensed Mesalazine rectal suppository instead of Mesalazine tablet
840613	Dispensed Paracetamol vial instead Paracetamol tablet
	Dispensing the wrong quantity
4420213	Dispensed wrong quantity of Omeprazole (20 vials instead 2 vials)
	Labelling wrong medicine strength
330313	Dispensed Amlodipine with wrong labelling dose (10mg instead 5mg)
430812	Labelled Nifedipine 10mg instead of Nifedipine 20mg
	Omission of an item
170613	Omission of Epinephrine dose, while the prescribed medicine did not dispensed
	Dispensing an expired medicine
760212	Dispensed expired Cyclosporine capsule for in-patient

4.3.2.2 Dispensing errors in L&D hospital

All of the dispending errors that occurred in L&D pharmacy were considered as unpreventable dispensing errors. Any dispensing errors identify in the accuracy check stage in L&D hospital pharmacy (prevented dispensing errors) usually reporting in especial form call “in-house incident forms”. The in-house incident forms were inaccessible for the purpose of this study due to ethical reasons because these reports include the name of the staff who did the errors. The total number of unpreventable dispensing reports in L&D hospital pharmacy was 49 incidents for the period from January 1, 2012 to June 30, 2013. Figure 4.5 shows the frequency of incidents for each month for the period from January 2012 to June 2013. An average of 4 dispensing errors occurred from January 2012 to October 2012 and then errors declined to one incident per month until March 2013. After that, the number of incidents increased to 5 in June 2013.

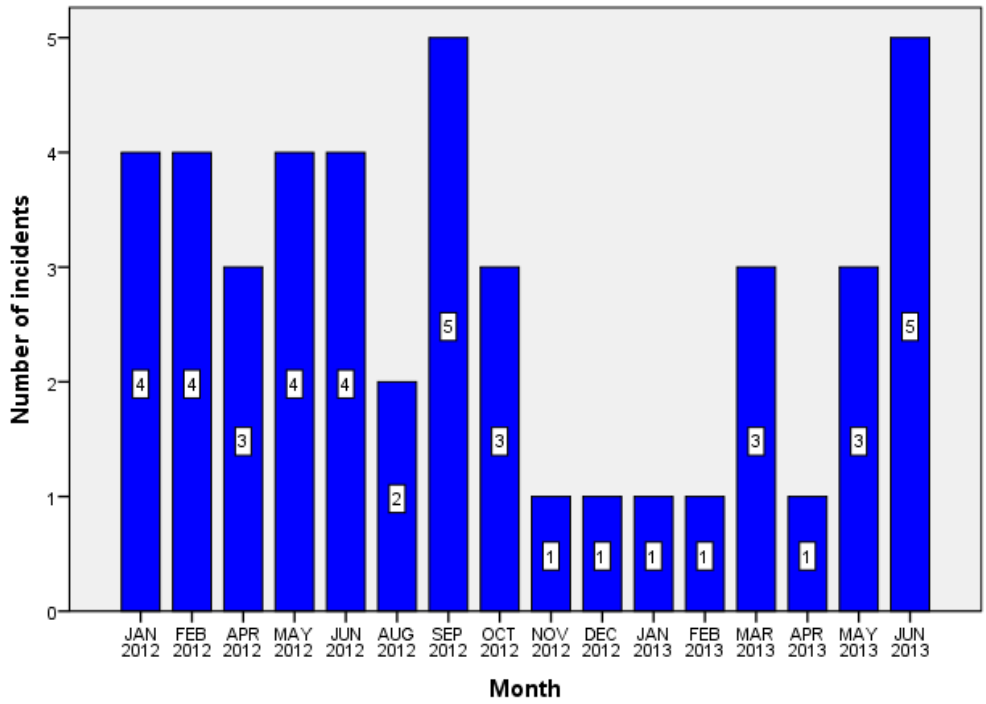

Figure 4.5: Distribution of unprevented dispensing errors for each month in L&D hospital pharmacy

Figure 4.6 shows the percentage (%) of dispensing errors in L&D according to the day of the week. The lowest percentage of incident reports occurred during weekend days (Saturday, 4% and Sunday 8.16%), while the maximum number of dispensing errors occurred on Friday (22.45%), Wednesday (18.37%) and Thursday (18.37%).

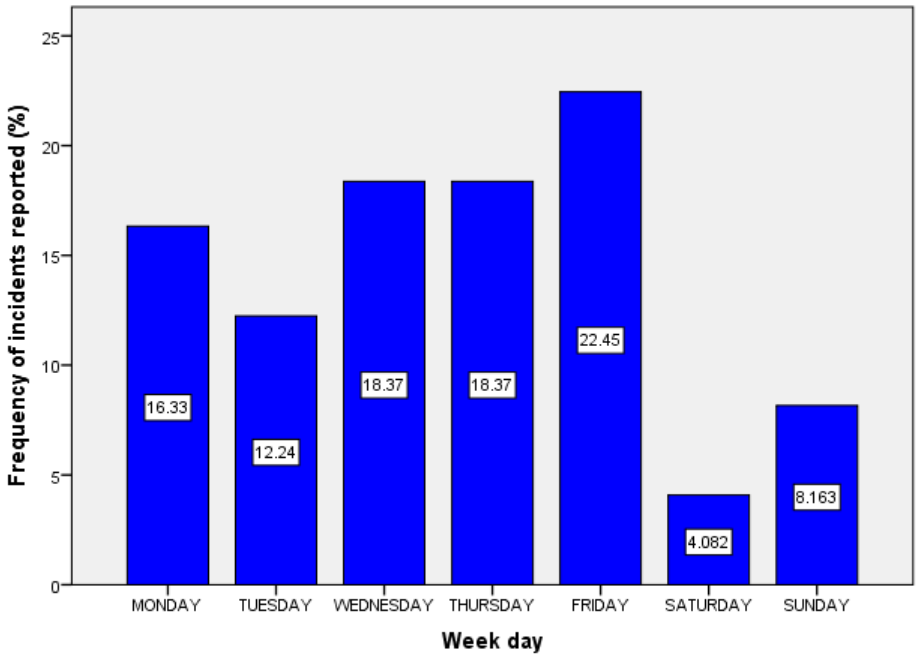

Figure 4.6: Percentage of dispensing errors reported for each day of the week in L&D hospital pharmacy

Table 4.13 shows the frequency of dispensing errors according to the type of dispensing error in L&D hospital pharmacy. Most of the errors (*n* = 9, 18.4%) were related to dispensing the wrong medicine. The next most common error was labelling the wrong strength (*n* = 8, 16.3%), followed by dispensing the wrong strength (*n* = 7, 14.4%) and labelling the wrong patient details (*n* = 6, 12.2%). To validate the dispensing errors classification, 5% (n= 5) of the data were independently classified by a clinical pharmacist. The level of agreement between the researcher and the pharmacist was 1 which means they were totally agreed on dispensing error classification.

Table 4.13: Frequency of dispensing errors according to the types of dispensing errors in L&D.

Type of dispensing error	Frequency (n)	Percent (%)
Dispensing the wrong medicine	9	18.4
Labelling the wrong medicine strength	8	16.3
Dispensing the wrong drug strength	7	14.3
Labelling the wrong patient name and detail	6	12.2
Labelling the wrong medicine name	4	8.2
Dispensing the wrong quantity -missing dose	3	6.1
Incomplete information in the label	3	6.1
Dispensing the wrong formulation	3	6.1
Completely wrong label	1	2
Dispensing an expired medicine	1	2
Omission of an item	1	2
Labelling the wrong instructions	1	2
Labelling the wrong expired medicine date	1	2
Total	49	100

Table 4.14 outlines the frequency of dispensing errors in L&D based on the classes of drugs (according to BNF classification). Central nervous system agents were most commonly involved in dispensing errors (29.8%), followed by malignant disease, immunosuppression agents (17%) and nutritional products (10.6%). Table 4.15 describes all the unprevented dispensing errors in L&D hospital pharmacy.

Table 4.14: Medications involved in dispensing errors (BNF V.65)

Medicine class	Frequency (n)	Percent (%)	Valid Percent (%)
Central nervous system	14	28.6	29.8
Malignant disease and immunosuppression	8	16.3	17
Nutritional and blood	5	10.2	10.6
Skin	4	8.2	8.5
Cardiovascular system	4	8.2	8.5
Infection	3	6.1	6.4
Gastro-intestinal system	3	6.1	6.4
Eye	2	4.1	4.3
Endocrine system	2	4.1	4.3
Respiratory system	2	4.1	4.3
Total	47	95.9	100.0
missing	2	4.1	
Total	49	100.0	

Table 4.15: Unprevented dispensing errors in L&D

ID	Dispensing error
	Dispensing the wrong medicine
78974	Dispensed Sodium chloride 600mg tablet instead of N-acetylcysteine 1.2g
78764	Dispensed Moxonidine 200mcg instead of Moxifloxacin 400mg
81164	Dispensed Dermovate cream instead Eumovate cream
82495	Dispensed Clonidine 25mcg instead of Clonazepam 0.25mg
82282	Dispensed Ceforoxime instead of Ceftriaxone
85390	Dispensed wrong drug Pentasa® instead of Asacil®
85498	Dispensed Hydralazine 25mg instead of Hydroxyzine 25mg
94806	Dispensed the wrong medicine
94698	Dispensed Aquacel Ribbon instead of Aquacel AG Ribbon
	Labelling the wrong medicine strength/dose
78973	Labelled Peginterferon alfa 150mcg instead of Peginterferon alfa 120mcg
79442	Labelled Morphine 5ml instead of Morphine 2.5ml
83227	Labelled Sotalol 80mg instead of Sotalol 40mg
85399	Labelled Dexamethasone 1.2ml instead of Dexamethasone 1ml
81677	Labelled Midazolam Buccal 10mg instead of Midazolam Buccal 5mg
80731	Labelled Bimatoprost 0.03% eye drops instead of Bimatoprost 0.01%
87266	Labelled wrong medicine dose, 6.2mls instead of 0.62mls
94697	Labelled Morphine 100mg instead of Morphine 10mg
	Dispensing the wrong drug strength
78973	Dispensed Peginterferon alfa 150mcg instead of Peginterferon alfa 120mcg
85395	Dispensed Enoxaparin 40mg instead of Enoxaparin 20mg
83227	Dispensed Sotalol 80mg instead of Sotalol 40mg
92720	Dispensed Mycophenolate 500mg instead of Mycophenolate 250mg
92048	Dispensed Methotrexate 5mg instead of Methotrexate 15mg
92901	Dispensed wrong concentration of Sodium chloride eye drops 5% instead of 9%
94502	Dispensed Epoetin alfa 6000 units instead of Epoetin alfa 10000 units
	Labelling the wrong medicine name
78974	Labelled Sodium chloride 600mg tablet instead of N-acetylcysteine 1.2g
82495	Labelled Clonidine 25mcg instead of clonazepam 0.25mg
85498	Labelled and dispensed Hydralazine 25mg instead of Hydroxyzine 25mg
94698	Labelled and dispensed Aquacel Ribbon instead of Aquacel AG Ribbon
	Completely wrong label (wrong label for the correct medicine)
81636	Completely wrong label for insulin
82805	Completely wrong label for Flucloxacillin (IV)
	Incomplete information in the label
83023	Ward and drug names were messed for Carbocisteine capsule
85748	Patient name & hospital number were missed in the label for TPN preparation
85781	Patient name & hospital number were missed in the label for TPN preparation

ID	Dispensing error
	Labelling the wrong patient name and detail
83226	All the information were correct in the label for Candesartan 16mg tablet except the patient name
85606	All the information were correct on the TPN bag label except the ward name
86056	All the information were correct in the label except the ward name (Ward 30 instead of Ward 20)
91717	All the information were correct in the label for Cetuximab except the patient name
91714	All the information were correct in the label for Cetuximab except the patient name
94652	All the information were correct in the label for Lamotrigine except the patient name
	Labelling the wrong instructions
85674	Labelled the wrong instructions, Paracetamol (two 5ml) instead of (5ml)
	Dispensing the wrong formulation
86555	Dispensed Cyclizine 50mg oral tablet instead of Cyclizine 50mg injection
90974	Dispensed Ranitidine tablet instead of Ranitidine injection
94375	Dispensed Haloperidol tablet instead of Haloperidol ampoules
	Labelling the wrong expired medicine date
86640	Labelling the wrong expiry date of Methotrexate 21/12/2012 instead of 28/9/2012
	Dispensing the wrong quantity
89827	Dispensed the wrong quantity of Buprenorphine patch 4 instead of 5 patches
91054	Dispensed the wrong quantity of Fentanyl 10 ampoules instead of 20 ampoules
94362	Dispensed the wrong quantity of Morphine 100mls instead of 500mls
	Omission of item
92121	Omission of Etoposide capsules (did not dispense the medicine for the patient)
	Dispensing an expired medicine
93389	Dispensed an expired Sodium bicarbonate injection for in-patient

4.3.3 Differences in unprevented dispensing errors reported at KSMC and L&D hospitals

This section describes the differences in the types of unprevented dispensing errors that occurred in KSMC and L&D hospitals only because the prevented dispensing errors were inaccessible related to ethics reason. While there were 20 unprevented dispensing errors found in KSMC, 49 unprevented dispensing errors were reported in L&D hospital. Table 4.16 outlines the number of unpreventable dispensing errors in both hospitals according to the types of dispensing errors.

Table 4.16: Frequency of unpreventable dispensing error in KSMC and L&D

Type of dispensing error	L&D	KSMC
Dispensing the wrong medicine	9	10
Labelling the wrong medicine strength	8	2
Dispensing the wrong drug strength	7	3
Labelling the wrong patient name and detail	6	-
Labelling the wrong medicine name	4	-
Dispensing the wrong quantity	3	1
Incomplete information in the label	3	-
Dispensing the wrong formulation	3	2
Completely wrong label	1	-
Dispensing an expired medicine	1	1
Omission of an item	1	1
Labelling the wrong instructions	1	-
Labelling the wrong expired medicine date	1	-
Total	49 (6.4%)	20 (0.33%)
Total of medication error	766	6101

All of the types of dispensing errors can be grouped into two main categories (I) content errors and (ii) labelling errors. The data contained many error types whose frequencies were not sufficient for statistical analysis. Breaking the types into content errors and labelling errors groups allowed for fisher's analyses. Figure 4.7 shows the numbers and the percentages of unprevented dispensing errors in the two hospitals according to content errors and labelling errors.

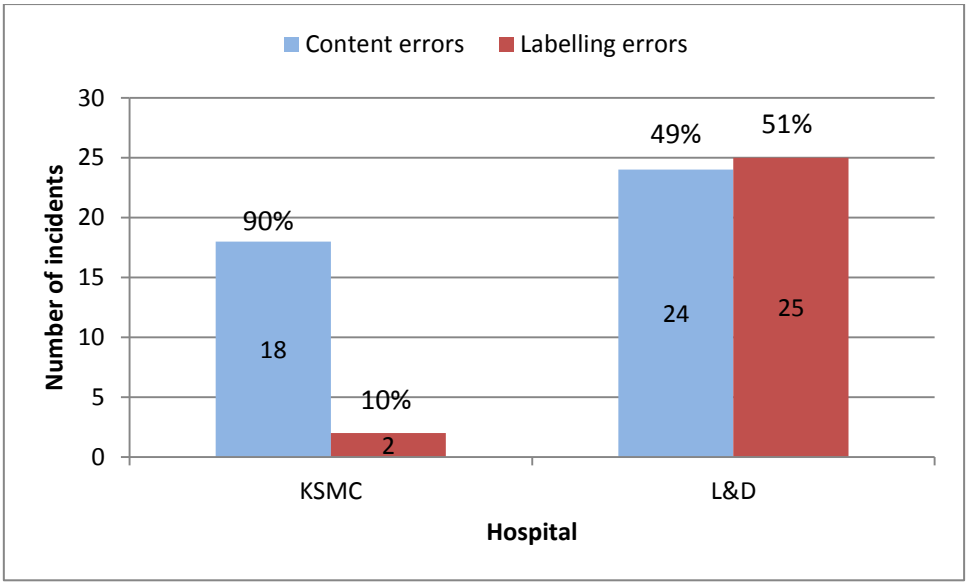

Figure 4.7: Number percentages of content and labelling errors in L&D and KSMC

The majority (90%) of errors at KSMC are related to content, whereas the errors at L&D are evenly split between content (49%) and labelling (51%). There are significant different between the two site, while the Fisher's test exact was applied to check whether there was a significant association between hospital site and error type ($F=0.002234$, $p < 0.05$).

4.3.4 Unprevented dispensing errors severity

Clinical pharmacists with experience in medication safety assessed the potential risk of the unprevented dispensing errors in KSMC and L&D pharmacies. The pharmacists were asked to classify the errors using five categories; catastrophic, major, moderate, minor and none risk (according to classification adopted from James et al. (2011). Figure 4.8 indicates the potential clinical significance of unprevented dispensing errors in KSMC and L&D pharmacies. The agreement among the reviewers' rating was a substantial agreement (0.66). About 73.6% (n=14) of the dispensing errors in KSMC and 66.6% (n=26) of the dispensing errors in L&D were classified as minor potential to harm the patient, if the error had not been intercepted and the patient took the medicine. Nearly 10% (n=2) of the unprevented dispensing errors in KSMC and 20.5% (n=8) in L&D were assessed as moderate potential risk. One dispensing error case was assessed as major potential risk in KSMC as the dispensary team dispensed Cefuroxime 750 mg vial instead of Vancomycin 500 mg for an in-patient. Dispensing errors that assessed as moderate risk are;

- Dispensed Sodium bicarbonate 375mg instead of Calcium carbonate 500mg(KSMC)
- Dispensed Perindopril 5mg instead of Prednisolone 5mg (KSMC)
- Labelling the wrong instructions for Morphine, two 5ml instead of 5ml (L&D)
- Labelling the wrong patient name for Lamotrigine (L&D)
- Labelling the wrong patient name for Cetuximab (L&D)
- Dispensed Mycophenolate 500mg instead of Mycophenolate 250mg (L&D)
- Dispensed Methotrexate 5mg instead of Methotrexate 15mg (L&D)
- Dispensed Sotalol 80mg instead of Sotalol 40mg (L&D)
- Dispensed an expired Sodium bicarbonate injection for in-patient (L&D)
- Omission of Etoposide capsules (did not dispense the medicine for the patient) (L&D)

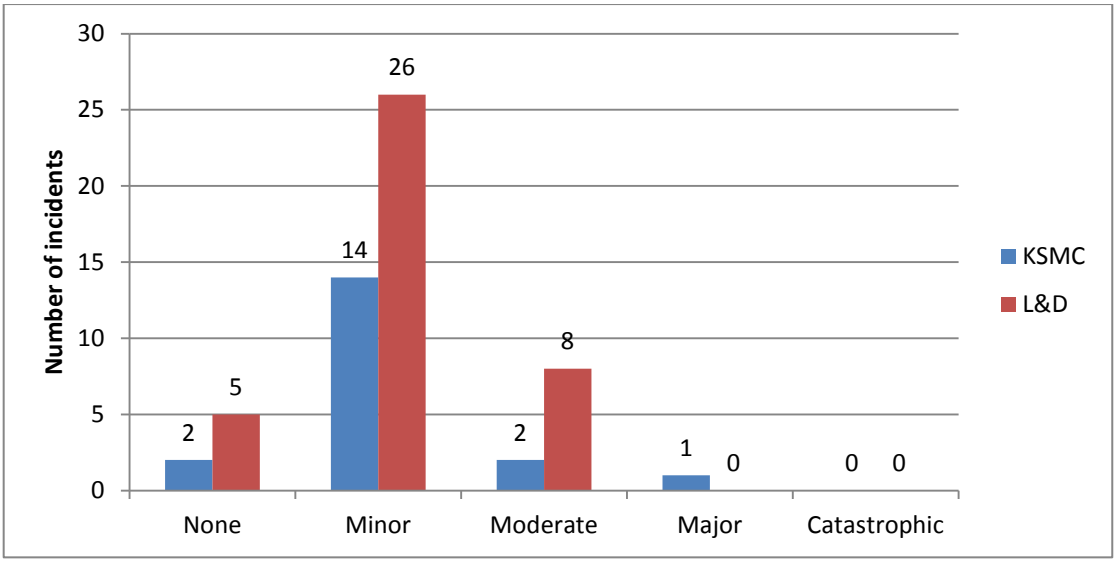

Figure 4.8: Potential clinical significance of dispensing errors in KSMC and L&D

4.4 Discussion

This study reviewed all medication errors reported in KSMC pharmacies in KSA and L&D (reported on Datix) in the UK over a period of 18 months to identify the nature of medication errors and dispensing errors. A comparison of the types of medication errors in the KSMC and L&D hospitals shows clear variations in the prevalence rate of these errors. In the L&D hospital, administration errors were the most common (49%), followed by prescribing errors (38.5%) and dispensing errors (6.4%). This distribution is nearly the same as those reported in England and Wales (NPSA, 2007d) and in the northeast of Scotland (NHS Grampian) (Alrwisan et al., 2011). In England and Wales, the most common medication errors reported to NRLS in 2007 were administration errors (59.3%), dispensing errors (17.8%) and prescribing errors (15.7%) (NPSA, 2007d). The most commonly reported errors in the northeast Scotland hospitals were administration errors (59%), prescribing errors (11%) and dispensing errors (10%) (Alrwisan et al., 2011).

In KSMC, the majority of reported medication errors occurred in the transcription stage (74.8%). The medicine safety officer of the KSMC hospital explained that transcribing errors were common in the hospital because the physicians gave verbal prescriptions to the nursing staff and asked the nurses to order the medicines using the physician's computer access (Al-Zaagi, 2015). Since September 2013, the hospital management has prohibited the nursing staff from ordering medicines on behalf of the physicians, a decision that led to a reduction of these errors in the KSMC hospital in the following months (Al-Dossari et al., 2014). Interestingly, administration errors in KSMC were very low (0.7%) compared with errors in other stages. This is because physicians and nurses were not reporting the incidents; rather, the majority of medication errors (97%) were reported by pharmacists (Al-Zaagi et al., 2013). Thus, the variation between KSMC and L&D in the prevalence rates of different types of medication errors may be related to the non-reporting of some incidents by physicians and nurses in KSMC. The variation in the rate of medication errors may also be related to the differences in the healthcare systems. For instance, a study conducted in US hospitals showed that the most common types of errors in the USA

differed from those in the UK and KSA. The study conducted showed differences in the prevalence rates of the types of medication errors in USA hospitals: Prescribing errors were the most common error (77%) reported in the hospitals, followed by administration errors (12.8%), transcribing errors (5.8%) and dispensing errors (1%) (Fortescue et al., 2003). The high rate of prescribing errors in this study may be related to the new clinical decision support systems that implemented in the hospital.

At the L&D hospital, the incidence rate of medication errors was nearly constant over the period studied. KSMC formally started reporting medication errors in January 2012 (Al-Dossari et al., 2014). Figure 4.1 and Table 4.8 show that the reporting rates for medication errors and dispensing errors were relatively constant from January to November 2012. After November 2012, the reporting rate increased until April 2013. The increase in the reporting rate is related to the fact that the hospital staff were encouraged to report incidents through the adoption of a blame-free culture in reporting medication errors; in addition, the staff were educated about the importance of reporting errors to improve patient safety (Al-Dossari et al., 2014).

The medication and dispensing error rates during the weekends in both hospitals were low. The rates ranged between 10% and 13.5% on weekends at KSMC, while on weekdays, they ranged from 13% to 18%. At L&D, the rates ranged between 4% and 10.5% on weekends and between 12% and 22.5% on weekdays. This could be attributed to the lower number of prescriptions dispensed during weekends. However, it is difficult to confirm whether the error rates were lower during weekends than during weekdays, because the number of dispensed items during weekdays was not available.

The study found 637 dispensing errors in KSMC. About 75% of these errors were committed by the pharmacy technicians, primarily because of two reasons. First, one of the main duties of pharmacy technicians is assembling the medicines. Second, the number of pharmacy technicians is higher the pharmacies in KSMC compared with

the pharmacists. However, the majority of dispensing errors (96.9%) were prevented, which means that they were detected during the dispensing process before the drug had left the pharmacy department. Twenty cases (3%) were unprevented dispensing errors, which means they were identified after the medication had left the pharmacy department. A similar rate was reported in a study by James et al. (2011). This is a strong indicator of the importance of the accuracy check stage for decreasing dispensing errors. In the present study, the most common category of dispensing errors in KSMC and L&D involved dispensing incorrect medicines and incorrect medicine strengths, which is consistent with previous findings in the UK (Irwin, 2011; James, 2011). The medicine that was most frequently dispensed incorrectly in KSMC was tenofovir/emtricitabine (Truvada®). Tenofovir was dispensed rather than Truvada® because the two have look-alike and sound-alike names, as shown in Figure 4.9. The drug that was most frequently dispensed in the wrong strength was cinacalcet, which has two strengths: 30 mg and 60 mg. This error is due to the similar packaging of the two strengths, as shown in Figure 4.10. Truvada® is recommened as initiating treatment for the HIV infection (Gazzard, 2008). However, there significant risk of dispensed Truvada® instead of Tenofovir but that can cost the hospital more.

Figure 4.9: The packaging of Emtriva® and Truvada®

Figure 4.10: The packaging of cinacalcet 60mg and cinacalcet 30mg

All the dispensing errors reported in L&D were unprevented errors. One of this study's limitations is that it did not have access to the in-house reports. The in-house reporting system encourages the pharmacy department staff to report prevented dispensing errors, which are errors that were detected before the drug had left the pharmacy department. The prevalence rate of prevented dispensing errors in the hospital pharmacies in previous published studies was about 97% of the identified dispensing errors, while the unprevented dispensing error rate was about 3% (Cina et al., 2006, James et al., 2011b). Reporting unprevented dispensing errors is an important tool to improve patient safety because it allows staff to learn from their mistakes (Crane et al., 2015).

Table 4.14 shows that the number of unprevented dispensing errors in L&D was higher than that of the unprevented dispensing errors in KSMC; however, the number of medication errors was higher in KSMC than in L&D. This does not mean that the L&D hospital is a poorly performing hospital. The actual total number of dispensing errors is uncertain, as some errors were not identified or were identified but not reported. For example, the number of dispensing errors reported in eight different sections at Central Arkansas in the USA was only 82 over four years

(Rolland, 2004). This is another limitation of the incident report method (James et al., 2011b). The number of labelling errors, especially labelling incorrect drug names, drug strengths and patients' names, was high in L&D. Labelling errors may be related to the lack of electronic prescribing; the pharmacy staff in L&D have to enter the prescription details, which could cause labelling errors. These results are similar to those of a study conducted in hospital pharmacies in the UK (James et al., 2011b).

The use of technology clearly has an impact on reducing dispensing errors (Nakajima et al., 2005). For example, using a computerised physician order entry (CPOE) system in KSMC helps reduce the number of dispensing errors associated with labelling. The percentage of dispensing errors associated with labelling in KSMC was 10% (n=2) for the unprevented dispensing errors and 14% (n=87) for the prevented dispensing errors. That is much lower than the percentage of labelling errors in L&D (49%, n=25). All the labelling errors in KSMC were related to labelling the incorrect medicine strength in situations where the pharmacy staff had to change the medicine strength in the CPOE according to its availability. However, several published studies have shown the role of CPOE in reducing dispensing errors (Nuckols et al., 2014, Moniz et al., 2011). Meanwhile, using pharmacy automation systems in L&D may have reduced the errors in assembling the medicines. In KSMC, 50% of the unprevented dispensing errors were a result of assembling the wrong medicines. Oswald and Caldwell (2007) conducted a study to compare the dispensing error rate before and after an automation system was implemented in a tertiary hospital in Canada. They observed that the dispensing error rate declined from 2.1% to 1.8% after the automation system was implemented.

Some of the prevented dispensing errors were repeated twice on the same day. For example, methyldopa was dispensed instead of dexamethasone, and fat emulsion was dispensed instead of Vitalipid. The same person made both of these errors. This indicates planning action errors (mistakes) rather than a lack of knowledge or a slip or lapse of concentration. Beso et al. (2005) applied mixed methods to investigate the dispensing errors in hospital pharmacy and found that the most common reasons for active failure were slips (52%) and mistakes (44%).

In the present study, the most common reasons for dispensing the wrong medicines in both hospitals were look-alike or sound-alike names; these were also the most common factors in previous studies (Beso et al., 2005, Irwin et al., 2011, James et al., 2008, James et al., 2011b). For example, moxonidine was dispensed instead of moxifloxacin in L&D and perindopril was dispensed instead of prednisolone in KSMC because of the look-alike names. Similar packaging is another reason for dispensing the wrong drug or wrong strength. For instance, nifedipine 10 mg was dispensed instead of nifedipine 20 mg in KSMC, and sotalol 80 mg was dispensed instead of sotalol 40 mg in L&D, as was Dermovate cream instead of Eumovate cream. All these medicines are reported as having confusing names in a list provided by the Institute for Safe Medication Practices (ISMP) (ISMP, 2015).

Labelling errors were high in L&D, especially labelling incorrect drug names, drug strengths and patient names. These results are similar to those of a study conducted in a community pharmacy in the UK, where the rate of dispensing errors associated with labelling errors was high at 36% (Ashcroft et al., 2005). The high rate of labelling errors may be related to a slip or lapse of concentration of the dispensary team member while selecting the medicine name or dose from the medicine list in the computer.

The most common medicines involved in dispensing errors in KSMC were cardiovascular agents and anti-infective agents. This is consistent with the fact that a high percentage of hospital patients in 2012 complained of cardiovascular disease or infectious disease (MOH, 2013).

The majority of unprevented dispensing errors identified in the KSMC and L&D pharmacies had minor or potential moderate clinical significance. This is consistent with the findings of previous studies (Bohand et al., 2009b, Cina et al., 2006, Irwin et al., 2011, James et al., 2008, James et al., 2011b, Rolland, 2004), where the majority of identified dispensing errors were of minor clinical significance or caused no harm. One dispensing error in KSMC had major potential risk, which means that it might have caused serious harm or death to the patient. In previous published studies,

some cases were serious and could have caused death; for example, a pharmacist dispensed an incorrect dose of verapamil (240 mg instead 40 mg) to an 86-year-old woman (Bohand et al., 2009b). Assessing the severity of the identified dispensing errors is helpful in raising the dispensary teams' awareness of the seriousness of dispensing errors and the importance of adhering to pharmacy policies and procedures (Barton, 2009). Some dispensers, especially those who do not have enough experience, may trivialise the omission of a dose, thinking that it does not cause any harm to the patient; in reality, the omission may cause serious harm or death, as is the case with etoposide. The omission of etoposide for a short period (a few days) may cause serious harm or death.

4.5 Conclusion

This section aimed to investigate the nature of dispensing errors reported in KSMC and L&D. A retrospective review of dispensing error reports for an 18-month period from January 1, 2012 to June 30, 2013 was conducted. The data was entered into a computer and analysed using SPSS. Descriptive statistics were used to calculate frequencies and percentages and Fisher's test was used to compare the unprevented dispensing errors in KSMC and L&D.

A total of 6,101 medication error reports in KSMC and 766 medication error reports in L&D were documented. About 10.3% (n=637) of the medication errors in KSMC were dispensary errors, and the majority (96.9%) were detected in the final check stage. Nearly 6.4% (n=49) of the medication errors in L&D were unprevented dispensing errors. The most frequently reported dispensing errors in KSMC were: dispensing the wrong medicine (n = 323, 50.7%), dispensing the wrong strength (n = 128, 20.1%) and labelling the wrong strength (n = 89, 14.0%). The most frequently reported dispensing errors in L&D were: dispensing the wrong medicine (n = 9, 18.4%), labelling the wrong strength (n = 8, 16.3%) and dispensing the wrong strength (n = 7, 14.3%).

Cardiovascular and anti-infective agents were the most common medicines involved in dispensing errors in KSMC, while in L&D central nervous system, malignant disease and immunosuppression agents were most commonly involved in dispensing errors. Pharmacy technicians committed the most dispensing errors in KSMC. The majority of the unprevented dispensing errors in both hospitals had minor or moderate potential clinical significance.

Chapter 5: Contributing factors leading to dispensing errors

5.1 Introduction

Merely identifying the various types of medication errors may not help to reduce such errors in the future. Contributory factors associated with medication errors need to be investigated, in order to enhance medication safety (Tang et al., 2007). Dispensing errors can be occur at any stage of the dispensing process but the majority occurred during preparing the labels and assembling of the medicines (NPSA, 2007a). Limited of studies researched the contributing factors that associated with dispensing errors. These studies investigated the dispensing errors contributing factors relied on the subjective reporting of perceived contributory factors by pharmacy staff in and incident reports (Irwin et al., 2011, James et al., 2011b, James et al., 2008), interviews (Anto et al., 2010, Beso et al., 2005) and survey (Peterson et al., 1999).

Dispensing error factors may vary from pharmacy to pharmacy. In previous studies of dispensing errors, several common factors have been reported to contribute to the errors, such as sound-alike and look-alike names of medicines, high workload, low staffing and interruptions during dispensing (Beso et al., 2005, James et al., 2008, James et al., 2011b). More contributory factors may be present in some hospitals—for instance, James et al. (2011) reported extra contributory factors in Welsh hospital pharmacies including; inexperienced staff, complex prescriptions and bad communication. The main objectives of this phase are:

- To investigate factors contributing to dispensing errors in KSMC and L&D pharmacies.
- To investigate the dispensary teams' perceptions of strategies to reduce dispensing errors.

5.2 Method

There are several different ways to collect qualitative data; however, the four primary methods include observation, interviews, focus groups and questionnaires (Trochim et al., 2015, Arhinful et al., 1996). As shown in Table 5.1, Arhinful et al. (1996) have summarised the main advantages and disadvantages for the different methods of obtaining responses. The questionnaire method is less expensive than other methods and can be distributed to large numbers of participants at different sites (Arhinful et al., 1996). Moreover, it can preserve anonymity, allowing the participants to feel freer to provide honest responses about workplace issues (Constantinos et al., 2011). Because no interviewer is available to help the participants, questionnaires must be well-designed and clear to participants; the questions need to be simple and written in an easy-to-understand manner (Phellas et al., 2011). Questionnaires involve three types of questions: closed-ended questions, open-ended questions and a mixture of closed-ended and open-ended questions (Kane and ScienceDirect, 2004).

Table 5.1: Advantages and disadvantages of the different methods of qualitative data collection

Method	**Observation**	**Interview** (Open-ended)	**Focus groups** (Open-ended)	**Questionnaire** (Open-ended)
Main advantage	-Permit evaluator to enter into and understand situation/context -Provide good opportunities for identifying unanticipated outcomes -Provide direct information about behaviour of individuals and group.	-Provide opportunity to explore topics in depth -Allow interviewer to explain or help clarify questions, increasing the likelihood of useful responses	-Focus groups can be relatively low cost and provide quick. -Participants may be more comfortable talking in a group than in an individual interview.	-Fast and cheap -Suitable for large size and geographically spread population. -Samples are relatively large, so results may be more generalizable. -Anonymous; getting honest and insightful feedback
Main disadvantages	-May affect behaviour of participants. -Expensive and time consuming. -Need well-qualified, highly trained observers.	- High setup costs. -Not suitable for long or complex questions. - Volume of information too large; difficult to generalise results.	- Groups can be difficult to assemble. - The small numbers in focus groups can limit; difficult to generalise results.	-Low response rate. - No control over how the questionnaire is answered. - Number of topics that can be explored

5.2.1 Participants

All pharmacists, pharmacy technicians and pharmacy assistants who are responsible for preparing and dispensing medicines at KSMC and L&D Hospital were invited to participate in this study. Qualitative research studies generally use small samples, since they are designed to extract detailed data. Qualitative research studies usually take time and do not need large samples (Richards, 2009). Therefore, the target population for this kind of study is less than the quantitative methods, in order to create rich data concerning the study questions and to generate a deep and detailed study (Tuckett, 2004). Depending on the research questions, it is generally accepted that around 60 to 100 participants are enough for this method (Wilmot, 2005), and pragmatically, it is estimated that no less than 30 and up to 60 participants (at least 15 participants from each hospital) would be sufficient for this qualitative investigation.

5.2.2 Questionnaire design

Designing the questionnaire is very important part of the research study. Meaningful responses from the participants can be obtained only if the questionnaire is structured efficiently, taking into consideration important aspects like reliability and validity of the information requested. Guidelines outlining the seven steps of the process of questionnaire design have been provided by Hague (2006) and these steps as the following;

1. Decide what data is required
2. Make a rough listing of the questions
3. Refine the question phrasing
4. Develop the response format
5. Put the questions into an appropriate sequence
6. Finalise the layout of the questionnaire
7. Pre-test and revise

For this study, self-administered questionnaires was designed to meet the project's objectives (appendix 9). All items were formulated after considering the results obtained from the quantitative aspect of this project conducted in KSMC and L&D. In addition, previously published paper (Peterson et al., 1999) used to formulate the questions. Base on that, the focus in the questions involved in the questionnaire were formulated to explore the dispensary teams' perceptions about the factors that contribute to dispensing errors and how to prevent these errors. Completing the questionnaire required about 20 minutes. The questionnaire contains two main sections, as follows:

Section One: Questions about participants: Job role and ask if the participant is involve in preparing/dispensing medicines. This section aimed to make sure the questionnaire completed the dispensary staff only.

Section Two: Questions about the contributing factors that associated with dispensing errors and how to reduce these errors. Also, this section has some questions about satisfied the participants about some strategies that implemented in their hospital.

Reliability and Validity: The concepts of validity and reliability must be applied to the investigation to enable the data, and thus the research findings, to be meaningful. Reliability refers to the degree to which measures, data and procedures are internally consistent or replicable. In this study, the questions received internal review by the supervisory team to ensure the reasonability and feasibility of the nature of the questionnaire items. For the reliability, the questionnaire was distributed to six pharmacists. This pilot study of this research, participants showed a good understanding of the questions.

5.2.3 Recruitment process

The local collaborators at KSMC and L&D Hospital distributed the online self-administered questionnaire form by email to all the dispensary team member in each respective hospital. A cover letter attached to the questionnaire explained the objective of the project and emphasised that participation in the questionnaire was

voluntary responses would remain confidential with anonymous representation. In the study, informed consent was not formally obtained from the participants; however, the act of sending a filled questionnaire was considered as consent to participate in the study. This information was provided to potential participants.

After 3 weeks a reminder email was sent to the dispensary teams by the local collaborators to encourage them to participate. To enhance the response rate, six weeks after the distribution of the questionnaire the researcher conducted a presentation in both hospitals about the study objectives and distributed hardcopies of the questionnaire for those in the dispensary teams who had not completed it yet. A presentation was conducted prior to distributing the questionnaires about the research objectives and the types of dispensing errors in the hospital. This was to stimulate the dispensary team to complete the questionnaires.

The completed online questionnaires were received by the researcher directly via Google documents. The completed hardcopy questionnaires were collected from the pharmacy department in KSMC, while the forms from L&D were sent back to the project team directly through the pre-paid envelopes supplied. Online questionnaire provides the highest level of convenience for the respondents because they can answer the questionnaire according to their own pace and chosen time (McDowell, 2006). The hardcopy questionnaire provided for how not has computer access in the hospital and may not have time to complete the questionnaire at home.

5.2.4 Data analysis:

Open-end questions usually provide qualitative data and there are several methods used to analyse qualitative data. Dawson (2002) presented four methods. The first is thematic analysis: themes usually emerge from the data and are not imposed by the researcher. Also, in this type of analysis, the researcher does not need to wait until he or she completes the data collection, so analysis can start once any part of the data is available. The second method is comparative analysis, which involves comparing and contrasting information that is obtained from the different participants, until the researcher is sure no more issues are identified. The third method is discourse or conversational analysis, which focuses on speech patterns, the frequencies of these patterns and their implications. The fourth method is content analysis, which is defined as 'any technique for making inferences by systematically and objectively identifying special characteristics of messages' (Berg, 2009).

The content analysis approach is one of the most popular approaches to analyse open-ended questions answers (Scobie et al., 2005, Krippendorff, 2012, von Kardorff et al., 2015). It is commonly utilised in health research to improve interpretation of data (Ahman et al., 2015, Graneheim and Lundman, 2004). Content analysis may be undertaken in an inductive or deductive way (Elo and Kyngas, 2008). There are three types of content analysis: conventional, directed and summative (Berg, 2009, Hsieh and Shannon, 2005). In the conventional content analysis, the coding categories are derived from the data directly. In the directed approach, initial codes obtained from a theory or relevant research are used as guidance to start the analysis. A summative content analysis involves counting and comparing words or content, followed by the interpretation of the underlying context (Berg, 2009, Hsieh and Shannon, 2005). Content analysis is an extremely useful method for analysing data that has clear research questions (Ezzy, 2002). The type of approach used here is directed content analysis because related research was undertaken in a literature review.

The data analysis began by organising and preparing the data for analysis, then reading all the data several times to gain a sense of it. After that, the data was read word by word to generate initial codes. In directed content analysis the initial codes such as sound-alike/look-alike names and inexperience staff obtained from relevant research. The next step was using the codes to generate the codes. Finally, a meaning or interpretation of the data was produced (Moretti et al., 2011, Hsieh and Shannon, 2005, Braun and Clarke, 2006, Creswell, 2013). In this study, the questionnaires' answers were entered into NVivo 10 qualitative analysis software for directed content analysis. Identified codes were grouped into categories, vetted by a member of the research team.

5.3 Result

This section describes the findings obtained from the response of participants from KSMC and L&D hospitals. A total of forty four responses were received from the hospitals. Twenty four members of the dispensary team in KSMC sent the questionnaire back: seventeen pharmacists (Ph) and seven pharmacy technicians (PT) (one questionnaire was not completed). Twenty responses were received from L&D: thirteen from pharmacists, six from pharmacy technicians and one from a pharmacy assistant. Four pharmacists did not complete the questionnaire, because they were not involved in preparing or dispensing of medicines

Labels were assigned to participants in order to their responses. The KSMC pharmacists were labelled as ***KSMC/Ph1*** to ***KSMC/Ph17*** and the pharmacy technicians were labelled as ***KSMC/PT1*** to ***KSMC/Ph6***. The L&D pharmacists were labelled as ***L&D/Ph1*** to ***L&D/Ph9,*** the pharmacy technicians were labelled as ***L&D/PT1*** to ***L&D/Ph6*** and pharmacy assistant was labelled as ***L&D/PA1***. A content analysis was applied to analyse the dispensary teams' answers about their experiences with dispensing errors. This is because these were reported as stated written. The codes and categories that emerged from the dispensary teams' answers are shown in Table 5.2.

Table 5.2: Summary of the main themes, sub-themes and categories that emerged from the participants' answers

categories	Codes
Task related error-provoking factors	Sound-alike drug names Similarity of packaging Complex prescriptions Illegible handwriting Similar patient names
Personnel related error-provoking factors	Communication and relationship problems Inexperienced staff Loss of concentration and fatigue Careless checking and low morale Urgent deadlines or hurrying through tasks Demanding patients Protocols not followed
Work environment error-provoking factors	Inadequate education Pharmacy logistics Distractions and interruptions High workload Low staffing Unsuitable computer system
Personal improvement strategies	Education & training Balancing heavy workload Reducing staff stress Communication and relationships Policy adherence
Work system improvement strategies	Reporting errors Auditing of errors Reflection on errors Stock management Pharmacy design Reduction of distraction Clear assignment of responsibility
Structural improvement strategies	Automation system Electronic prescribing system

Several factors contribute to the dispensing errors in both hospitals. These error-provoking factors were classified under three categories: task-related, Personnel-related and work environment–related.

5.3.1 Task related error-provoking factors

Look-alike and sound-alike drug names and **similarity of packaging** were the most reported dispensing error factors in both hospitals. The participants assembled the wrong medicines due to the similarity of the medicines' names or packaging. Some of the new staff did not recognise that similar medicines were present in the pharmacy. Also, in KSMC there are annual contracts with medicine suppliers that lead to frequent changes in the medicines' packaging and brand names; some of these medicines have similar names or packaging shapes. However, some L&D dispensers mentioned that implementing the automation system in the pharmacy helped to reduce assembling errors, but some errors still occurred, relating to similar names of medicines or strength during the selection of the medicine from the medicine list on the computer system in the L&D hospital (JAC system).

"There are very similar medicine in regard of shape and names." (KSMC/Ph6)

"The hospital has a yearly treading with suppliers and contractors to provide medicine. Sometime, with new contract comes a whole different list of medicines which also very similar to medicine produce from diffident brand medicine." (KSMC/Ph6)

"The wrong strength could just be down to operator error where it is selected from a list of medication." (L&D/PT6)

"Drugs with similar names are either filed next to one another on the shelves or are above one another on the JAC system when labelling and/or picking items form the robot." (L&D/Ph7)

The ambiguity of the prescriptions, caused by factors such as **illegible handwriting** and **complex prescriptions,** were reported as factors associated with dispensing errors in L&D only. Some of the participants in L&D reported poor handwriting on the prescriptions as a contributory factor for dispensing errors, along with the complex prescriptions of Electronic Prescribing and Medicines Administration (EPMA) for the discharge patients' prescriptions (TTA's), while the dose set out in two different lines in some prescriptions. The dispensary team in KSMC did not comment about the prescriptions. A participant from KSMC reported the similarity in names of the patients as a dispensing error factor.

"Confusion from hand writing on hand written requests. Poorly written hand-written requests." (L&D/PT4)

"EPMA TTA's are not very easy to read and easy to get dosing wrong. EPMA TTA's are not always set out logically (dose for some medication may be set out on 2 different lines)." (L&D/PT6)

"Similar name of patient" (KSMC/PT1)

5.3.2 Personnel related error-provoking factors

Pharmacy staff, physicians, nurses and patients are involved in that factor but the majority factors are related the pharmacy staff. **Lack of communication and poor relationships** among the dispensary team, or between the dispensary team and other healthcare professionals in the hospital, have been reported as a dispensing error contributory factor. Lack of senior support, and the lack of professionalism of some pharmacists when dealing with the other dispensary team members, can affect some staff, which may lead to dispensing errors.

"Lack of effective communication between pharmacist and physicians" (KSMC/Ph17)

"Lack of professional skills and interest among pharmacy technician due to the down look from their pharmacist colleagues." (KSMC/Ph9)

"Lack of senior support" (L&D/P3)

Lack of experience of new staff has been reported as a contributory factor to the dispensing errors in both hospitals. The dispensary team in KSMC reported that sometimes inexperienced staff worked on the night shift alone, or carried out the final accuracy check, which led to a lot of errors.

"Lacking experience for some of new employee in the pharmacy department" (KSMC/Ph1014)

"Inexperienced members of staff." (L&D/Ph5)

"Sometimes no qualified pharmacist in the night shift" (KSMC/PT3)

A large number of participants in both hospitals reported **fatigue and loss of concentration** as dispensing errors contributing factors. Some of the dispensers mentioned some factors that may cause fatigue and loss of concentration, such as life stress, talking on phone or in person to another member of staff during dispensing, doing multiple tasks at once, doing the same work for long periods without any break or work rotation, noises in the pharmacy and empty the delivery boxes and put the stock on the pharmacy shelves in the busiest hours. Also, the dispensers lost concentration at the end of the day.

"Less concentration during work due to personal issue or talking to colleagues." (KSMC/PT1)

"Supply the pharmacy by the medicines in the busy hours which may lead to less of concentration during prepare the prescriptions" (KSMC/PT4)

"Tiredness/lack of breaks for repetitive tasks." (L&D/Ph7)

Careless checking and low morale have been reported as contributing factors associated with dispensing errors in both hospitals. Some of the dispensers were careless about checking their own dispensing and depended on the last check (final accuracy check).

"Some employees are carless in work" (KSMC/Ph11)

"Low morale → people don't care. People not taking responsibility for own dispensing – they think it's being double checked so ok to make mistakes" (L&D/PT3)

Hurrying through tasks may increase the possibility of errors occurring during dispensing. The participants reported that they hurried up when there were a high number of prescriptions that needed to be dispensed, or if the prescriptions came to the pharmacy at the end of the day.

"Rush hours when you have to work faster." (KSMC/Ph1)

"Pressure to dispense quickly e.g. to finish a late night quicker, when more outpatients prescriptions are waiting." (L&D/PA1)

Participants reported some contributory factors associated with the patients. For example, the participants from KSMC and L&D reported that some **patients demanding** their medicines from the dispensary team may cause errors.

"Also, sometimes the patients are rushing the pharmacy staff and asking them about their medications several times." (KSMC/PT3)

"People rushing..." (L&D/Ph2)

A lot of the participants in KSMC pointed out that **not following protocols and policy** may lead to a failure to identify the dispensing errors in the pharmacy. For example, some participants mention that the final check is sometimes not implemented or some tasks are performed by an unqualified dispenser.

"Sometimes the cleaners arrange the medications without supervision" (KSMC/Ph9)

"Technicians dispense medication alone without double check." (KSMC/Ph11)

"Most the policies and decisions on the papers not performed and if it performed with no quality" (KSMC/Ph12)

"Double checking Rx is not done properly, e.g., looking to the label only but not to medication inside it." (KSMC/Ph1)

"Sometimes no double check especial in the night shift" (KSMC/Ph2)

5.3.3 Work environment error-provoking factors

The dispensary teams in KSMC and L&D reported that the **inadequate education** of the staff was one of the causes of errors occurring in the dispensing process. The participants mentioned that lack of education about previous errors may lead to the

same errors being repeated. A large number of participants in KSMC complained of the lack of education in their pharmacy. For example, they mentioned that there were no regular meetings or lectures for the pharmacy staff to educate them about the previous errors, the newly available medicines in the pharmacy or about any role changes. Also, they mentioned that there was not any effective training for new staff.

"No continues education about our errors" (KSMC/PT1)

"Lack of training. Lack of appreciation how serious errors are." (L&D/Ph2)

In KSMC, participants reported contributory factors associated with the **pharmacies logistics** of arranging the medicines alphabetically on the pharmacy shelves, which may lead staff to put medicines with similar names together. Also, the medicines in the pharmacy were sometimes arranged by unqualified people, which may lead to the medicines being put in the wrong positions. Some of dispensary staff complained about the pharmacy's design in general as a contributing factor, and two participants added that, to them, the pharmacy's size is small and not comfortable to work in, considering the workload that they carry out in there. Another contributory factors that emerged from the participants' answers was the patients congregating at the pharmacy windows, because there is no waiting area for them, and the number of pharmacy windows not suitable for the pharmacy's workload. In addition, the dispensers complained about the lack of a rest room for the pharmacy staff. On the other site (L&D), a dispenser complained about the lack of chairs in their pharmacy as illustrated in the excerpts below:

"Sometimes the wrong medication or wrong strength arranged in the wrong shelf by the servant in the pharmacy without anybody of the staff or the person responsible to arrange the correct drug in the shelf" (KSMC/Ph10)

"Patients have no waiting area and consulting room" (KSMC/Ph6)

Sometime the place of dispensing area outpatient is not suitable or comfortable for the pharmacist (KSMC/Ph17)

No space between some medicines which lead to mix these medicines together. (KSMC/PT4)

No chairs in dispensary on your feet all the time body aching (neck, feet & back, legs) (L&D/PT1)

Working in an untidy environment (L&D/PT1)

Distraction and interruptions were reported by the dispensary teams in KSMC and L&D as contributing factors to errors occurring during dispensing of the medicines in the pharmacy. Some of the participants in KSMC mention in their answers; distraction and interruptions caused by chatting, high workload, empty the delivery boxes and put the stock on the pharmacy shelves in the busiest hours and unauthorised persons entering the pharmacy to enquire about some medicines. The dispensary staff in L&D also point to distraction and interruption in their dispensary as causes, such as chatting during dispensing, high workload, phone calls and being interrupted by patients.

"…accumulation of patients at the pharmacy windows. Also, sometimes the patients are rushing the pharmacy staff and they asking the pharmacy staff about their medications several times." (KSMC/PT3)

"… the entering of unauthorized people to the pharmacy such as physicist and nurses' cause disturbing the pharmacist." (KSMC/Ph6)

"Distraction from your task from phones, others staff and patients." (L&D/PT4)

Many of the pharmacy staff in both hospitals complained in their answers about the **high workload**. They also pointed out that a high workload results in errors occurring, as it leads to loss of concentration, speeding up the task, not taking a rest break and not implementing the final accuracy check. The pharmacy staff also mentioned **low staffing** levels as one of the contributory factors involved in dispensing errors, and this is a common factor that leads to an increase in the workload.

"Lacking of staff, this lead to too much workload on the staff" (KSMC/Ph11)

"In the rash hour miss double check" (KSMC/Ph7)

"Staff pressures (shortage and sickness)" (L&D/PT6)

Some of the dispensers in KSMC hospitals reported some issues with the **computer system** which may lead to errors, and that the current method of listing the medicines in the software leads to the selection of the wrong medicine or strength.

"Poor computer system" (KSMC/Ph12)

"Down level of system during work time" (KSMC/Ph13)

After the participants listed the contributory factors associated with the dispensing errors, they reported some solutions and strategies to reduce these errors in their dispensary. These strategies gathered in three categories; personnel improvement strategies, work system improvement strategies and structural improvement strategies.

5.3.4 Personnel improvement strategies

The participants listed strategies to improve patient safety and decrease errors while dispensing medicines. **Educating and training** the dispensary team was the most reported strategy to decrease dispensing errors. Several topics for education have emerged from the participants' answers; these include educating the pharmacy staff about previous dispensing errors, and educating them about the look-alike and sound-alike medicine names and similar packaging for the medicines available in the pharmacy. Also, the dispensary team in L&D recommended specific education for new staff and trainees, such as reading the Policy Operative System (P.O.S) and doing the dispensing logs 100 times before working without supervision. The dispensary team in KSMC recommended educating the pharmacy staff through weekly meetings with all pharmacy staff and regular lectures and presentations, or individual feedback to the dispenser who made the error and asking the dispenser to correct his/ her mistake.

"Train the staff and trainers about similar names, packages and different strength available. Also, after the updating the medicine from the contractor, there should be a training session to updating the red tags and the sound alike medicine." (KSMC/Ph7)

"Always asking the dispenser to correct their own discrepancies to allow them to learn from their mistakes, and getting dispensers to double check their work against the prescription." (L&D/Ph7)

The participants from L&D mentioned that they have already implemented weekly meetings in their pharmacy for all the pharmacy staff to discuss dispensing errors or any updates concerning the pharmacy or hospital. Also, there is a training programme for new staff, and new dispensers have to complete dispensing logs before they are allowed to carry out unsupervised dispensing. However, they recommended regular feedback about dispensing errors. In contrast, the dispensers in KSMC complained about the inadequacy of education in their pharmacy; there was only limited education on making the pharmacy staff aware about the serious errors caused by look-alike and sound-alike medicine names using posters, which needed updating.

"Posters about the look-like and sound-like medicine in the pharmacy but need to update because medications may be change every year depend on supply companies." (KSMC/PT4)

"Feedback on performance, training & awareness raising of the importance of reducing errors." (L&D/Ph5)

The participants in both hospitals suggested employing more staff to **balance heavy workloads** in the pharmacy, and sending the discharge prescriptions in early in the morning to avoid accumulating the prescriptions at the end of the day. Moreover, organising the workflow can help to avoid high workloads. A KSMC dispenser recommended setting up a satellite pharmacy in emergency pharmacy, and an L&D dispenser recommended dispensing the out-patients' prescriptions in the community pharmacies.

"Complex TTAs should be done in the morning when it is less busy." (L&D/Ph8)

"Open pharmacy in the emergency department to cover discharge patient prescriptions, this lead to decrease the load of work in the inpatient pharmacy working 24 hours" (KSMC/Ph8)

"Move all Out-Patient prescriptions to community chemist which will support a calmer environment" (L&D/PT5)

Reducing staff stress, through frequent and compulsory breaks in both hospitals and providing a quiet room in KSMC for relaxing during the breaks were suggested to help keep the dispensers' concentration high during the day.

"Breaks and rest room needed for the pharmacy staff." (KSMC/Ph3)

"Quite room for relaxing during the breaks" (KSMC/Ph4)

"Frequent and compulsory breaks." (L&D/Ph7)

The participants in both hospitals believe that **improving the communication and relationship** between the staff in the pharmacy will improve the environment in the dispensary, which should lead to reduced errors during dispensing.

"Good relationship between the pharmacy staff and supervisors are needed" (KSMC/PT4)

"More support from management" (L&D/PT1)

Policy adherence was strongly recommended by participants to reduce dispensing errors. These policies include doing self-checks, having a final accuracy check by a qualified pharmacist and avoiding using abbreviations. Enhancing the implementation of the policy can be done by the direct supervision and the support of the dispensary team. Also, the participants recommended regular policy updates.

"Double check should be done by pharmacist only." (KSMC/Ph35)

"Inforce the staff to follow the policy and procedure" (KSMC/Ph4)

"Ensure procedures are followed. Encourage dispensers to check their work before passing on" (L&D/Ph1)

5.3.5 Working system improvement strategies

The participants reported several procedures to enhance patient safety though understanding the causes and contributing factors associated with dispensing errors that had occurred, including **reporting identified errors, auditing and analysing the reported errors** and **reflecting on the error**. The KSMC pharmacy staff mention that reporting errors and auditing the errors were implemented in their practice, but needed improvement; the current reporting is manual, which consumes time and effort filling in the form and carrying out analysis. They therefore recommended implementing an electronic reporting system to avoid time-consuming processes and to improve data access. The L&D participants recommended daily monitoring of the prevented dispensing errors to raise the dispensers' awareness.

Several improvement strategies associated with **stock management** emerged from the participants' answers. These strategies included arrangement of the medication in the pharmacy alphabetically, separating look-alike/sound-alike medicines in the shelves, colouring the font of the medicine's name in the pharmacy shelves and

using caution red tags note on shelves to alert the dispenser that this medicine has look-alike and sound-alike medicines. Keeping the high alert medicines separated in a special cabinet to avoid serious errors, high alert medicines are the medicines that have heightened risk of causing significant patient harm such as anticoagulants. Using tall-man lettering, where part of a medicine's name is written in upper case letters on the pharmacy's shelves, to help distinguish sound-alike, look-alike drugs from one another in order to avoid dispensing errors, was suggested. Most of these strategies need to be applied in KSMC, while at the L&D hospital some of these strategies need to be implemented for medicines that are not stored in the robot.

"Separated between medications that are similar in shape and color of name by using sound-alike/look-alike sticker on container" (KSMC/Ph17)

"Arrangement the medication in the pharmacy by using alphabetical" (KSMC/PT3)

"Shelving clearly make for items that are not in the robot." (L&D/Ph2)

The participants in KSMC thought that the pharmacy management needed to re-design their pharmacies in KSMC, in order to reduce dispensing errors. Other suggestions included improving the pharmacy design by having a waiting area for patients, a counselling room and a rest room for the pharmacy staff.

"Re-design the pharmacy to improve workflow" (KSMC/Ph7)

"Large and quite waiting area are needed for the patient who's waiting their medication."

(KSMC/PT3)

"Quite room for relaxing during the breaks" (KSMC/Ph3)

The participants in both hospitals believe that **reducing distractions** in the pharmacy will improve the environment in the dispensary, which should lead to reduced errors during dispensing. Distractions can be reduced through avoiding chatting and personal phone calls in the dispensary, avoiding pharmacy cleanness during the busiest hours, preventing unauthorised people entering the pharmacy and educating

the patients about the dispensing process and the usual time taken for dispensing. Also, avoid empty the delivery boxes and put the stock on the pharmacy shelves during the busiest hours. Some of these strategies are already implemented in L&D, where phone calls and chatting are not allowed in the dispensary area, and there is a poster explaining the dispensing process for the patients in the waiting area, to make them aware that they may need to wait for a long time during the dispensing process.

"Decrease distracting factor to improve concentration" (KSMC/Ph1)

"Educate the patients about the dispensing process and the times needs for preparing their medications." (KSMC/PT3)

"Avoid distribution factors during prepare the medicines such as taking with another staff" (KSMC/PT3)

The dispensary team recommended some strategies to improve dispensing operations in their dispensary. The pharmacy staff in KSMC requested **clear assignment of responsibility** to each member of staff in the pharmacy to reduce errors during dispensing.

"In general arrange of job description for employees. Pharmacists check the medication & technician for preparation & pharmacist for dispense the medications" (KSMC/Ph11)

"Identify the tasks between the pharmacy staff and organize the tasks (who is receiving the prescriptions, print the labels, collect the medicines, double check hand the medicines to the patients)" (KSMC/Ph2)

5.3.6 Structural improvement strategies

The dispensary teams suggested using tools such as **automated systems** and **electronic prescribing**. The KSMC participants recommended implementing automated systems in their pharmacy to reduce assembling errors, while electronic prescribing is already applied in KSMC. The automated system is already implemented in L&D, but the dispensers suggested the implementation of electronic prescribing to avoid errors associated with illegible handwriting.

5.4 Discussion

In this phase of the study, an open-ended questionnaire was sent to the dispensary teams in KSMC and L&D to obtain their views on two areas: the contributory factors associated with dispensing errors in the hospital and the strategies to reduce errors during dispensing. A total of 44 responses were received from the hospitals: 24 from the KSMC team and 20 from the L&D team.

5.4.1 Contributory factors associated with dispensing errors in the hospital

Some contributory factors that were mentioned were associated with the product itself, such as look-alike and sound-alike medicine names, similar packaging and several strengths and forms available for a particular medicine. These factors were reported more often by the KSMC participants, who assemble the medicines manually. However, these factors were also reported by the L&D participants, who select the medicine name from the computer list or assemble medicines that are not in the automation system. These factors are also commonly associated with dispensing errors in other hospital pharmacies (Irwin et al., 2011, James et al., 2011b, Anto et al., 2010, James et al., 2008, Beso et al., 2005). These contributing factors have been identified in community pharmacies as well (Emmerton and Rizk, 2012, Nordén-Hägg et al., 2012).

The L&D team reported the ambiguity of prescriptions as a dispensing error factor, as some prescriptions were written manually and some were written in illegible handwriting or were complex. Since electronic prescribing is implemented in KSMC, none of the pharmacy staff in the KSMC team complained about that issue. However, L&D is currently progressing towards implementing an electronic prescribing system in the hospital, which will help prevent dispensing errors associated with the ambiguity of prescriptions. It was also noted that doing more than one task at the same time, such as answering the phone or counselling patients during dispensing duties, or doing the same tasks for a long period can confuse the dispensary team staff.

One of the dispensing error factors reported by the KSMC team was the similarity of patients' names. The Saudi community consists of big families, which leads to several patients in the hospital having the same first and family names. There are some barriers to checking that the right patient is given the medicine in question, especially for the outpatient prescriptions, which do not contain the patient's address or date of birth. Therefore, it is important to find a method to identify the right patient to avoid dispensing medicines to the wrong patients. For instance, pharmacies in the UK usually identify the right patients through their address and date of birth.

Life stress, lack of experienced staff, carelessness of staff and hurrying through tasks have also been reported as contributory factors associated with dispensing errors in both hospitals. These factors have been reported in other studies as well (Irwin et al., 2011, James et al., 2011b, Anto et al., 2010, James et al., 2008, Beso et al., 2005). The KSMC participants frequently reported not implementing the final accuracy check. The reasons mentioned for not following this procedure include working alone, a high workload and the lack of a qualified person to do this task. Most of these issues occur because of the lack of direct monitoring and appraisal of the dispensary team. The pharmacy administration team needs to investigate whether errors occurred because of the dispenser's lack of experience, in which case he/she needs to undergo re-training, or because of the dispenser's negligence, in which case he/she needs to be accountable.

Several participants in both hospitals mentioned a loss of concentration as a factor in dispensing errors. The participants from both hospitals agreed that the causes of losing concentration are as follows: high workload, chatting while assembling medicines, lack of rest breaks, working the night shift, and emptying the delivery boxes and putting the stock on the pharmacy shelves during the busiest hours. The KSMC staff also identified important issues in their dispensary that distract the pharmacy staff, such as unauthorised staff (nurses and physicians) entering the pharmacy and patients congregating around the pharmacy windows. Distraction and interruption have also been noted in previous studies as contributory factors to

dispensing errors (Beso et al., 2005, Irwin et al., 2011, James et al., 2011b). Hence, these contributing factors must be considered to reduce the dispensing errors.

Keeping the dispensers' concentration high during working hours is important to avoid errors while dispensing medicines. Thus, the pharmacy administration team should make the pharmacy quieter by preventing distractions and interruptions during the dispensing of prescriptions. Chatting or phone calls should be prohibited in the dispensary area. Pharmacy deliveries should be received and stock should be put on the shelves early in the morning before the busiest hours (11 am to 3 pm). In addition, the pharmacy administration team in KSMC needs to prohibit unauthorised staff from entering the dispensary area to avoid distracting the dispensary team.

The pharmacy staff in the KSMC team also mentioned the dispensary design as a contributory factor to dispensing errors. Pharmacy size, limited dispensing windows and the lack of a patient waiting area and staff rest room were reported as factors contributing to errors in KSMC. Other issues reported in KSMC were related to the arrangement of medications in the pharmacy, such as the lack of barriers or enough space between the medicines, which led to staff mixing the medicines together. Another reported factor was that unauthorised persons (cleaners) empty the delivery boxes and put the stock on the pharmacy shelves, which may lead to the medicines being put in the wrong place. In Al-Arifi's (2014) study on dispensing errors in community pharmacies in KSA, 440 of the 800 dispensers reported dispensary design as the main factor contributing to errors. In the present study, the L&D team's use of an automation system solved the issues associated with selecting medicines from the shelves. Only one pharmacy technician in the L&D team complained about the lack of chairs in the pharmacy.

KSMC is currently undergoing development; new tower blocks are replacing the old buildings. According to the medication safety officer of KSMC, all the previous contributory factors associated with the pharmacy design of KSMC will be considered in the new buildings (Al-Zaagi, 2015). SpaceMed (2013) suggested that the size of the outpatient pharmacy depends on the number of prescriptions (Table 5.3). The suitable pharmacy size, number of windows, patient waiting areas, staff rest rooms

and patient counselling rooms should be taken into account in the design of the new pharmacies. The task of emptying the delivery boxes and putting the stock on the pharmacy shelves should be carried out by a qualified person who has good knowledge of the medicines.

Table 5.3: Estimating the Size of an Outpatient Pharmacy

Number of daily prescription	Pharmacy size (feet square)
Less than 100	The minimal size 500 ft^2
100 to 300	900 to 1,500 ft^2
300 to 500	1600 to 2200 ft^2
More than 500	More than 2300 ft^2

The KSMC dispensers added two more points when they were asked about the reported errors: lack of root cause analysis of the reported errors, and inadequate education about these errors. They noted that the identification of how errors occur is the first step to improving patient safety. So, the hospital needs an expert on root cause analysis to identify all possible errors causes in KSMC. The L&D participants were satisfied about current error monitoring and the audits for the unprevented dispensing errors, but some of the participants recommended monitoring the prevented dispensing errors in order to enhance the dispensary team's knowledge about the contributory factors.

The majority of the contributing factors that reported in the two hospitals are similar to the findings of previous research that conducted in the other hospital pharmacy or community pharmacy. These factors include look-alike/sound-alike medicines, staff inexperience, high workload and low staffing (Szeinbach et al., 2007, Ashcroft et al., 2005, Beso et al., 2005, Costa et al., 2008, James et al., 2008). However, the most common contributed factors that reported in the community factors were the illegible handwriting and the poor communication with the physicians (Ashcroft et al., 2005, Szeinbach et al., 2007).

5.4.2 Strategies to reduce dispensing errors

The participants highlighted the education of the dispensary team as an important step to improve the staff's abilities and therefore minimise their errors. The participants in both hospitals reported that new staff and trainees must read and understand the P.O.S first and work under supervision until they perfect their work. Moreover, all the dispensers need to raise awareness about the observed dispensing errors to avoid them. They also need to communicate any new pharmacy procedures through frequent meetings to increase the dispensing quality. The teaching and training of dispensary teams is recognised as an important tool to enhance patient safety and mitigate dispensing errors (Desselle, 2005).

The majority of dispensing errors may be caused by new staff members' lack of knowledge/experience. Thus, the pharmacy administration team needs to create a training programme to educate new staff about the pharmacy and the hospital's policies and procedures. The new staff members need to be rotated in the pharmacy department for training purposes under senior supervisors and to be made aware of the contributory factors associated with dispensing errors. The L&D pharmacy department has already implemented a training programme for new staff, and new dispensers have to complete dispensing logs before they are allowed to carry out unsupervised dispensing. The pharmacy department administrator in KSMC needs to organise a weekly meeting to make all the pharmacy staff aware of dispensing errors and policy updates; this is already being done in L&D. However, the KSMC hospital needs to organise a wide variety of training such as packages and development programmes for the pharmacists, pharmacy technicians and pharmacy assistants to ensure continuous staff development.

Some recommendations were reported concerning balancing heavy workloads in the pharmacy. Employing more staff is one of the recommendations in both hospitals to avoid an excessively high workload. But employing more staff may not be a suitable solution because it requires extra funding. Other recommendations to reduce the workload in L&D include dispensing outpatient prescriptions in the community pharmacies and sending the discharge prescriptions to the pharmacy early in the

morning before the busiest hours. Some hospital pharmacies in the UK have adopted these measures; the patients can take their prescriptions to the community pharmacies near or in the hospital, such as the Royal Liverpool University Hospital, Royal Blackburn Hospital and East Lancashire Hospitals (Wright, 2010). Terry et al. (2011) reported some problems with dispensing hospital prescriptions in community pharmacies. Commonly reported problems include: illegible prescriptions, unfamiliar drug and missing information on the prescription, for example, quantity. They recommended printed prescriptions and the inclusion of the prescriber's contact details to resolve these problems. The KSMC participants believe that opening a new pharmacy in the emergency department and implementing an automation system can help reduce the workload in their dispensary. Some studies conducted in hospital pharmacies (James et al., 2011a, James et al., 2013) have found that automation helps reduce the dispensers' workload, improves dispensing efficiency and reduces the rate of dispensing incidents.

Maintaining a high number of dispensers on duty during dispensing is important to avoid errors. Taking frequent breaks and providing a quiet room for relaxing during breaks were recommended to avoid errors, since staff need to have regular rest breaks and meal breaks for at least half an hour daily to improve their performance and their ability to organise workflow efficiently and safely (Cohen, 2007). The UK has a law that gives workers the right to take breaks if they work for six or more hours. Saudi hospitals also give their staff the right to take rest breaks and meal breaks. Neglecting to take structured meal breaks and rest breaks for any reason may contribute to an increase in errors during dispensing.

A pharmacy technician reported the poor relationship between the pharmacy technicians and pharmacist as a factor contributing to errors. Some pharmacy technicians did not ask the pharmacist about any ambiguity in the task; this was related to the lack of friendship between them. The relationships among the pharmacy staff can be developed by understanding pharmacist and pharmacy collaboration (McDonough and Doucette, 2001).

Monitoring and reporting errors are among the most effective strategies to reduce dispensing errors and other patient safety incidents. Reporting the identified errors can help by making the dispensers and pharmacy team aware of their errors (Barton, 2009). Auditing and analysing the reported errors helps investigate the contributory factors associated with dispensing errors. The reporting system in KSMC is currently done manually by completing medication error forms; hence, a participant recommended implementing an electronic reporting system in their practice. Nakajima et al. (2005) listed some benefits of implementing an electronic incident reporting system, such as easier access to the reports, shorter time to complete them, legibility of reports, easier and faster monitoring, and sharing of information and security of access by responsible persons only. However, there are several barriers to reporting incidents, including the lack of feedback on previous reported incidents, the lack of time to complete long forms and the lack of knowledge about how to report incidents (Elder et al., 2007).

Reflection on errors is also recommended to enhance patient safety. In this process, the dispensary staff member describes the causes of the errors and lists some recommendations to avoid the errors in the future. Reflective practice is known as one of the most useful procedures in improving patient safety by minimising the individual factors that lead to medication errors (Pezzolesi et al., 2013). Reflecting on errors is an effective strategy to investigate the errors' sources from the dispensary team's point of view. Unfortunately, the majority of Saudi hospitals, including KSMC, do not have reflection polices or practise the concept of reflection, as they depend on the quality department to assess and formulate their safety policies.

Good design, good work flow during the dispensing process and the clear assignment of responsibility for each pharmacy staff member are important to enhance safety during dispensing. The KSMC pharmacy administration team needs to consider how to improve the pharmacy design and work flow during the dispensing process, since bad dispensary design and poor work flow are reported as contributory factors to dispensing errors in the KSMC pharmacy. The NHS has published a booklet called *Design for Patient Safety: A Guide to the Design of the Dispensing Environment.* This

booklet shows how the pharmacy design can make the dispensing process safer. The L&D has a good pharmacy design similar to that described in the booklet, which leads to a good dispensing process flow. The L&D pharmacy design and dispensing flow are demonstrated in Figure 5.2. A participant from L&D complained of a lack of chairs in the dispensary area, which can lead to body aches. Having contacted the National Pharmacy Association, Royal Pharmaceutical Society and NHS there is no evidence to suggest they avoid providing chairs in the pharmacy. However, the nature of the dispensers work usually requires standing all the time in the dispensary.

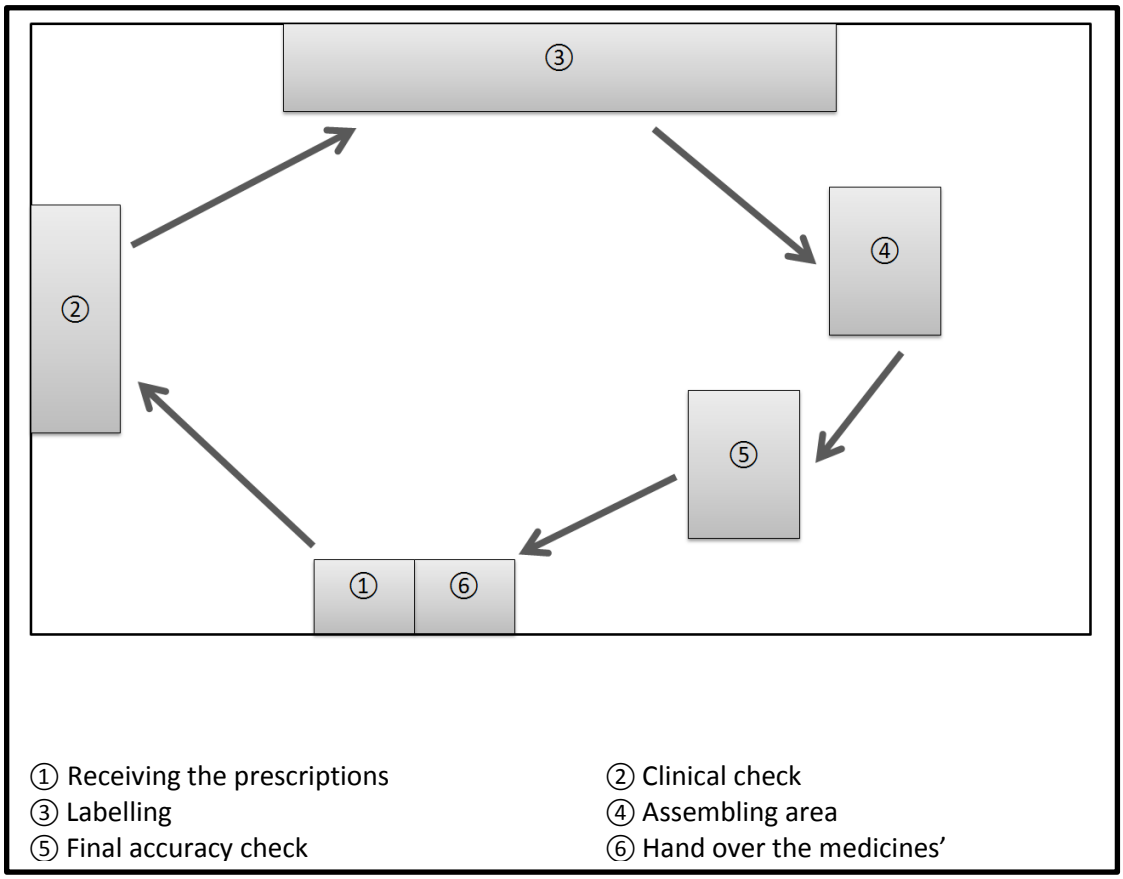

Figure 5.2: Pharmacy design and dispensing flow in L&D

The KSMC participants reported that several patients demand their medicines from the pharmacy staff, which may cause errors. Educating the patients about the dispensing process can help address this problem. The L&D hospital pharmacy has a poster explaining the dispensing process and its estimated required time, which

helps reduce the patients' demands. Figure 5.3 shows the L&D hospital pharmacy poster.

Figure 5.3: L&D hospital pharmacy poster to educate the patients about the dispensing process

Technology is also used to reduce dispensing errors. When asked about the current procedures applied to reduce dispensing errors in their hospital, the KSMC participants cited the electronic prescribing system (CPOE), while the L&D participants mentioned the automation system (robot). Electronic prescribing and automation systems are important technologies for enhancing dispensing accuracy. Numerous published studies have discussed the role of electronic prescribing in reducing medication errors (Cunningham et al., 2008, Eslami et al., 2008, Gandhi et al., 2005). Moniz et al. (2011) highlighted the impact of using electronic prescribing to reduce dispensing errors by avoiding the ambiguity of prescriptions. The automation system has also been proven as a means to reduce dispensing errors (Carmenates and Keith, 2001, Teagarden et al., 2005). These studies recommended implementing electronic prescribing and automated systems to improve patient safety.

5.5 Conclusion

This chapter identified contributory factors associated with dispensing errors in KSMC and L&D hospitals, and investigated the dispensary teams' perceptions with regard to potential improvement strategies to reduce the dispensing errors in their dispensaries. A total of forty four dispensers from both hospitals participated in this study. Several factors led to dispensing errors in the hospital pharmacies; some of these factors are common to both hospitals, while some of the factors were reported in either hospital.

Similar medicine names or packaging was one of the common factors in both hospitals. Using the automation system helped to reduce the assembling of wrong medicines, but some of the errors occurred because of the similarity of some of the medicines' names and the method for their display in the automated system. Other common factors were associated with the pharmacy teams, and included poor relationships and communication between the pharmacy staff, lack of the staff experience, fatigue and loss of concentration during work, low morale and hurrying through tasks. Moreover, common dispensing error factors associated with the work environment were noted, such as distraction and interruptions in the dispensary, not following the pharmacy policy procedures and high workloads.

Ambiguity of the prescriptions is a contributory factor reported in L&D, where the majority of the prescriptions are written manually. Thus factor was not reported in KSMC, where the hospital has used electronic prescribing since 2006. In contract, there are some factors that may enhance the occurring of dispensing errors in KSMC, such as inadequate staff education, the pharmacy design and the similarity of the patients' names.

Several strategies are recommended by the participants to enhance safety during dispensing tasks, for instance, focusing on the development of the dispensary staff will help to reduce the dispensing errors through their education and training, especially that of new members; and reducing staff stress by ensuring that the staff get enough breaks and providing a quiet room for relaxing during breaks. Reporting identified errors and root analysis of these errors are important methods for

reducing dispensing errors. Furthermore, improving the work environment helps to increase patient safety in the pharmacy, through changes such as good design for the pharmacy, improving the communication between the staff and avoiding distraction and interruptions for the dispensary team. Also, policy adherence and clear assignment of responsibility for each member of the pharmacy staff are further important factors. Using electronic systems, such as the automation system, electronic prescribing and electronic reports, are useful technical solutions for reducing dispensing errors.

Chapter 6: Summary and conclusion

6.1 Summary

Medication errors are common and can occur in any healthcare setting. According to an IOM report (2006), medication errors harm 1.5 million Americans every year and cost $3.5 billion (Partin, 2006). Medication errors mainly occur during the prescription, administration and dispensing stages (NPSA, 2007c, Lisby et al., 2005, Alakhali et al., 2014, Karthikeyan and Lalitha, 2013, Kirke, 2009). The majority of medication error studies have investigated errors in the prescribing and administration stages; very few have explored them in the dispensing stage at hospital pharmacies. Nonetheless, dispensing errors are common in healthcare institutions: approximately 11,000 dispensing errors were reported to the NPSA in 2006 (NPSA, 2007c). This research therefore has focused on dispensing errors in hospital pharmacies.

The types of dispensing errors vary from hospital to hospital and depend on the dispensing process and facilities available. As described in Chapter 1, the KSA has a different healthcare system, and, to our knowledge, there have been no studies conducted to investigate dispensing errors in hospital pharmacies in SA or any other Arab country.

A systematic review was undertaken to identify the best available evidence concerning the nature and contributory factors associated with dispensing errors in hospital pharmacies. Researchers have studied dispensing errors extensively in community pharmacies, but few studies have investigated this phenomenon in a hospital pharmacy environment. Our systematic review confirmed this observation as only 15 studies were conducted in hospital settings in four countries: the UK (6), Brazil (4), the USA (3) and France (2).

The majority of the reviewed studies identified only the nature of the dispensing error. Only five studies reported on the contributing factors associated with dispensing errors. The review studies noted that the most common type of dispensing errors were providing the wrong medicines or the wrong strength of the medicines. An omitted dose was the most common dispensing error type in studies focused on identifying errors in the unit dose system (Anacleto et al., 2005, Bohand et al., 2009b, Costa et al., 2008, Rissato and Romano-Lieber, 2013). The reviewed studies reported the following common contributing factors: look-alike/sound-alike medicines, inexperience staff and high workload.

Direct observation and reviewing incidents reports were common methods of investigating dispensing errors in the reviewed studies. Some studies applied incident reports or interview methods only (Anto et al., 2010, Beso et al., 2005, Irwin et al., 2011, James et al., 2008, James et al., 2011b). Meanwhile, the dispensing errors rate identified in these studies relied on observation methods (Bonifacio Neto et al., 2013). One study reported on the contributing factors and rate of dispensing errors (Beso et al., 2005). This study used a combination of methods: observations and interviews. Using a mixed methods approach is recommended for studying the nature and contributory factors of dispensing errors; for instance, one might use an incident report review with interviews or questionnaires (Michel, 2003, Lisby et al., 2005).

This study employed a quantitative and qualitative approach to gain valuable information related to the nature and factors associated with dispensing errors in two different hospital settings. Four main types exist to mix quantitative and qualitative methods, including triangulation, embedded research, and explanatory and exploratory designs (Creswell, 2009). In this study, explanatory design was applied to answer the research questions. It should be noted that the quantitative method preceded the qualitative method.

This research consisted of three phases. First, in phase 1, published studies were systematically reviewed to evaluate the scope of the literature on errors that occurred during the dispensing process in hospital pharmacies. Phase 2 involved the

identification of dispensing errors through a retrospective review of medication incidents reported at KSMC and L&D; in this way, the nature of dispensing errors was identified. Phase 3 included a qualitative exploration of factors perceived to contribute to dispensing errors and strategies for reducing these errors.

Research findings indicated that dispensing errors were the third most common type of medication errors at both hospitals. After transcribing errors and prescribing errors, dispensing errors were more common at KSMC. Administration errors and prescribing errors preceded them at L&D hospital. Dispensing the wrong medicine and dispensing the wrong strength were the most common types of dispensing error for both hospitals. Labelling errors, such as labelling the wrong strength and labelling the wrong medicine, was reported more commonly at L&D compared to KSMC. This difference could be attributed to the fact that L&D has implemented an electronic prescription system.

Reviewing incident reports alone may not provide enough evidence regarding contributory factors associated with dispensing errors. Therefore, self-administered qualitative questionnaires were distributed to the dispensary teams at KSMC and L&D. The questionnaire was formulated after considering previously published papers and the findings obtained from the quantitative component of this research. The questionnaire sought to investigate the perceived factors contributing to dispensing errors as well as strategies to reduce these errors.

After receiving the prescription, clinical screening is usually the first step in the dispensing process, and it is an important one—it has the capacity to improve patient safety. A qualified pharmacist screens the prescriptions to check the dose and other related issues, such as drug-drug or drug-disease interactions (Alakhali et al., 2014). In a study by Fernández-Llamazares et al. (2012), the clinical pharmacist in a Spanish paediatric hospital avoided 1,475 prescribing errors in 61,458 electronic prescriptions by carrying out the clinical check for prescriptions discharged at the pharmacy. L&D has implemented the clinical screen step, but the absence of clinical pharmacists at KSMC made it difficult to practice such a process for dispensing medicines. Due to the shortage of clinical pharmacists at KSMC, the current role of

the hospital's clinical pharmacist includes reviewing the prescribed medicines in the in-patient chart as well as counselling the in-patients about their medicines and therapeutic drug monitoring. However, clinical screening of the received prescriptions remains an important intervention to reduce prescribing errors and ADEs, but not dispensing errors.

Preparing and printing labels is usually the second step in the dispensing process. In some hospital pharmacies, errors are common during this step. For instance, the majority (51%) of the dispensing errors detected at L&D were labelling errors, especially labelling with incorrect drug names, drug strengths and patient names. Labelling errors were also common in 20 hospital pharmacies in Wales (James et al., 2011b). There are several contributory factors associated with labelling errors, such as similarities in medicine names and the different strengths or forms available for certain drugs. The influence of these factors was stronger for inexperienced staff, as some new staff members did not recognise the different strengths and dosage forms available for certain medicines.

Hastily selecting medicines from the medicine list on the computer also leads to an increase in labelling errors: for example, selecting clonidine 25mcg instead of clonazepam 0.25mg, or selecting hydralazine 25mg instead of hydroxyzine 25mg, both of which occurred at L&D. Some of the dispensers checked the first letters of the medicine name, then selected the wrong medicines from the list without checking the whole name, strength and form. Moreover, the ambiguity of prescriptions was reported as a factor associated with dispensing errors at L&D. For instances, some errors were caused by illegible handwriting or by complex printed prescriptions; meanwhile, medication dosage was sometimes written on two different lines.

To reduce labelling errors, it is recommended that dispensers conduct self-checks before generating the label. In addition, administrators should educate new staff members about medicines that have sound-alike and look-alike names or different strengths and forms. Some researchers have also suggested the use of an alerts program for medicines with similar names on the computer (James et al, 2008).

However, using electronic prescription has contributed to decreasing labelling errors at KSMC, where the pharmacy staff not required to enter the prescriptions in the computed system. Many published studies present the role of electronic prescriptions in reducing dispensing errors (Moniz et al., 2011, Agrawal, 2009, Forni et al., 2010).

At the majority of hospitals, dispensing errors occur mainly when assembling the medicines. For example, the majority of the dispensing errors at the KSMC pharmacy happened while assembling the medicine from the pharmacy shelves. Errors included selecting the wrong medicine, the wrong strength or the wrong form. Look-alike/sound-alike medicine names and inexperienced staff members were reported as contributory factors to dispensing the wrong medicines. These factors clearly appeared in this study's cases of dispensing errors: for example, the dispensers at KSMC discharged tenofovir instead of tenofovir/emtricitabine (Truvada®) 32 times. Furthermore, similar packaging sometimes causes the discharge of the wrong drug or strength. For instance, nifedipine 10 mg was dispensed instead of nifedipine 20 mg.

A final accuracy check is the last step in the dispensing process before handing the medicine to the patient. It is an important stage of the dispensing process, and it is a key strategy in perceiving and preventing dispensing errors. Traditionally, the final accuracy check should be done by a qualified person. For instance, only pharmacists can carry out the final accuracy check at KSMC, while at L&D, it is done by a pharmacist or an accuracy checking technician (ACT). One study indicates that approximately 97% of dispensing errors were detected in the final accuracy check (James et al., 2011b). The importance of the final check was obvious in KSMC data, where 96.9% of the dispensing errors were prevented.

KSMC and L&D reported several factors that contribute to the occurrence of errors during the dispensing process: high workload, inexperienced staff, phone calls, fatigue, hurrying through the task and carelessness about conducting the double check. KSMC participants reported more contributing factors at their pharmacy:

inadequate education, poor pharmacy design, not performing the final check, chatting during dispensing, poor communication, relationships between staff members and interruptions from patients and hospital staff. The KSMC participants also reported that medicine delivery and stocking the shelves often occurred during the busiest hours.

The participants reported several strategies for reducing dispensing errors. Participants at both hospitals agreed on the importance of education and training programs for reducing dispensing errors. KSMC participants recommended re-designing the pharmacy and the dispensing process workflow. Moreover, they suggested the implementation of an electronic reporting system and RCA technique to analyse such incidents.

These research findings show the dispensing error types and contributing factors that differ between countries. The majority of dispensing errors at the L&D hospital pharmacy were labelling problems, while KSMC had more content errors. The participants at KSMC reported some contributing factors unique to their pharmacy, such as the entrance of an unauthorised person in the pharmacy and a lack of frequent meetings for the pharmacy staff. However, such findings indicate the need to conduct more research to investigate dispensing errors in various countries due to the variety of healthcare systems and cultures. This research identified the contributing factors associated with dispensing errors at KSMC and L&D. However, further exploration is needed to investigate some of the contributing factors, such as the causes of the high workload and not following the policy. For such research focus groups or interviews (qualitative) could be used.

6.2 Conclusion

Dispensing errors are a common concern to the pharmacy profession. This study aimed to identify avoidable errors so to reduce patient harm and improve safety. This research has used a mixed methods approach to investigate and identify the nature of dispensing errors at KSMC and L&D pharmacies. The study also explored contributory factors associated with dispensing errors and strategies for reducing these errors. Dispensing the wrong medicine or the wrong strength were the most common dispensing error types for both hospitals. Labelling errors were also common at L&D. The most common contributory factors were the following: look-alike/sound-alike medicines, high workload, lack of staff experience, fatigue and loss of concentration during work, low morale, hurrying through tasks and distraction during the dispensing process. Other contributory factors included prescription ambiguity for L&D, and pharmacy design and dispensing work flow at KSMC.

Safety during dispensing tasks could be increased by focusing on staff development, which will help to reduce dispensing errors through education and training, especially for new staff members. In addition, safety can be enhanced by reducing staff stress, ensuring that they have enough breaks and a quiet room for relaxing during such breaks. Important methods for reducing dispensing errors include reporting identified errors and undertaking root cause analysis of these errors. Furthermore, improving the work environment can help to increase patient safety in the pharmacy; these changes could include implementing a good design for the pharmacy, improving the communication between staff members, and avoiding distractions and interruptions for the dispensary team. Further important factors include policy adherence and clear assignment of responsibility for each member of the pharmacy staff. Using electronic systems, such as automation systems, electronic prescriptions and electronic reports system, are useful technical solutions for reducing dispensing errors.

6.3 What this study adds

By integrating the findings of this study, KSMC and L&D hospitals can gain a fuller picture of the occurrence of dispensing errors. We have demonstrated the types of dispensing errors, factors associated with these dispensing errors, and the experiences and perceptions of the dispensary team about dispensing errors. Most importantly, we were able to form preliminary conclusions regarding the extent to which dispensing errors are a real problem at these hospitals. Data obtained from this study will certainly help develop, or even implement, procedures to reduce dispensing errors in hospital pharmacies. In addition, the comparison between KSMC and L&D hospitals in terms of incidence, types, factors and staff perceptions of dispensing errors could help both hospitals to develop strategies to reduce these errors. This thesis proposes several ideas, factors and recommendations surrounding dispensing errors occurring in hospital pharmacies. Further exploration could confirm findings and identify more factors causing dispensing errors.

6.4 Strengths and limitations of the research

Strengths

- This research was supported by the use of a comprehensive literature review in order to identify the extent of the problem and the appropriate method for future research.
- A mixed method approach was adopted, which enhanced the capability to answer the research questions.
- The L&D Hospital in the UK and KSMC in KSA were selected on the basis to learn from the advantages of each healthcare system.

Limitations

- The examined dispensing incidents were too few in KSMC and L&D, because the analysed medication error reports don't provide the actual number of the dispensing errors that occurred within the study period. This is because some errors were not detected, or detected but not reported.
- Data on prevented dispensing errors in L&D (in-house report) were not included in this study due to limited access.
- Lack of information about the dispensing errors' outcomes and the patients involved in the errors in the incident reports. These data would have been helpful to determine the clinical significance of unprevented dispensing errors.

- Lack of details about the dispensed item numbers, which will help to confirm some findings; for example, to check if dispensing errors at the weekend have a lower frequency compared with other days.
- The sample size of dispensary team included in the study could affect the generalizability of the study.

6.5 Recommendations

Some specific recommendation that may help to reduce the dispending errors in KSMC and L&D:

KSMC

- A comprehensive training program is needed for the new staff and trainees. They must understand the P.O.S first, and they should then have to work under supervision until they perfect their work; implementing the dispensing logs at least 100 times before working without supervision will assess if they can do their work.
- Continuing education for all the dispensary team, updates on dispensing issues and policy through weekly meetings with all pharmacy staff and regular lectures and presentations, and individual feedback to the dispenser who made the error, asking the dispenser to correct his/ her mistake.
- Commitment to a final accuracy check by a qualified person, before handing over the medicine to the patient or the patient's representative.
- Improve the environment in the dispensary through reducing distractions in the pharmacy, which will help to reduce errors during dispensing. Distractions can be reduced through avoiding chatting and unnecessary phone calls in the dispensary, avoiding supplying the pharmacy in the busiest hours, preventing unauthorised people entering the pharmacy, and educating the patients about the dispensing process and the usual time taken for dispensing through posters in the patients' waiting area.
- Reducing staff stress, through frequent and compulsory breaks and providing a quiet room for relaxing during the breaks, which will help to keep the dispensers' concentration high during the day.
- Balancing of the high workload in the pharmacy by dispensing the discharge prescriptions earlier in the day, and arranging breaks and annual leave among the dispensary team so as to avoid staff shortages.
- Implementing an electronic reporting system in the hospitals may help to reduce the dispensing errors and patient safety incidents, so long as the electronic reporting

system has easy access for all the hospital staff, in order to avoid time-consuming processes and to improve data access.

- Regularly auditing the incident reports, and using a root cause analysis method to determine the multiple, underlying contributory factors.
- Formulating an error reflection form, and encouraging the consider team to describe the causes of errors and to list some recommendations to avoid these errors in the future.
- Good design, a good flow of work during the dispensing process and the clear assignment of responsibility for each member of the pharmacy staff are important to enhance safety during dispensing.
- Implementing an automation system (robot) may help to decrease dispensing errors, especially when there is a high workload in the pharmacy.

L&D

- Balancing the high workload in the pharmacy by dispensing the discharge prescriptions earlier in the day.
- Implementing electronic prescribing for all the prescription types may help to reduce dispensing errors that occur because of the ambiguity of the prescriptions, and the subsequent selection of the wrong medicine, strength or form from the computer list.
- Distinguish similar medicines that are not in the robot. Several strategies can help to distinguish similar medicines, such as separating the similar medicines on the shelves, using tall-man lettering, colouring the font of the medicine's name on the pharmacy shelves and using caution red tag notes on shelves, in order to alert the dispenser that a medicine has look-alike and sound-alike medicines.

6.6 Reflections during the research process

Choosing the research topic idea started from the first month of my job as a pharmacist in a hospital pharmacy. One of my colleagues dispensed digoxin 0.25mg instead of 0.125mg, which almost led to the death of a patient. With time, I recognised that dispensing errors are common, so I began to search for information about the contributory factors associated with dispensing errors. During this time I was lacking the basics of research, as I depended on the Google search engine.

Looking back, I realise just how much I have learnt throughout this research process. Learning the research skills has had a strong personal impact, and I realise how much that has affected my personal character. I have improved my research skills and learnt to utilise the most suitable methodologies for answering research questions and addressing the required objectives.

Furthermore, throughout the quantitative and qualitative methods conducted in the study, I have learnt how to implement healthcare research procedure and make use of the available policies and facilities. The process of ethics application has provided me with an insight into the significance of ethical issues surrounding the research. Although I was familiar with the KSA hospital policies, I was introduced to UK hospital policies and procedures at the L&D Hospital. While working there, I also learnt how to access their databases, obtain dispensing error records and extract the relevant information required for the research. I believe that I have gained collaboration and team-working skills while working with the hospital staff (including the pharmacy), who supported me throughout the whole research process. I have received professional training at the hospital, which has helped me to acquire knowledge in the clinical aspect of my project. In addition, UH offered me generic research training which enhanced both my theoretical and practical research skills. For instance, the SPSS statistics courses have enabled me to choose the right tests for data obtained from the quantitative approach. In addition, I have learnt how to choose the most suitable method to analyse qualitative data. Moreover, with the help of my supervisors, I have learnt at the University of Hertfordshire how to

communicate with experts and involve them in the research process. My supervisors helped me to develop my problem-solving skills through addressing the many challenges that were encountered during data collection in both the UK and the KSA. Overall, I have learnt many transferable skills in the quantitative study, including designing research, ethical procedures, undertaking research with collaborators, data extraction and data analysis.

I found conducting my research towards achieving a PhD a very enjoyable process, during which I have gained crucial knowledge about my research and appreciated the application of the most appropriate methods to achieve the research objectives.

6.7 Research Output

- ALDHWAIHI, K., UMARU, N., PEZZOLESI, C. & SCHIFANO, F. 2016. A systematic review of the nature of dispensing errors in hospital pharmacies. Integrated Pharmacy Research and Practice, 5, 1-10.
- Aldhwaihi K, Umaru N, Schifano F, Pezzolesi C. An evaluation of dispensing errors at King Saud Medical City pharmacies. Poster presented at 4th International Conference on Healthcare Systems Ergonomics and Patient Safety, Taiwan, 23-26 June 2014.
- Aldhwaihi, Pezzolesi, Schifano, Umaru. An evaluation of dispensing errors at King Saud Medical City pharmacies. Poster presented at the University of Hertfordshire Research Conference, Hatfield (UK), April 9-10, 2014.
- Aldhwaihi, Pezzolesi, Umaru, Schifano. An evaluation of the types and contributing factors of dispensing errors in Luton and Dunstable hospital pharmacy. 21st Congress of the EAHP 'Hospital pharmacists taking the lead - partnerships and technologies'', Vienna (Austria), 16-18th March 2016.
- MSc Pharmacy Practise Research Presentation Evening; University of Hertfordshire. Wednesday, June 17th 2015: The nature of dispensing errors in hospital pharmacies (Presentations)
- Pharmacy Practice Presentation and Research Showcase Evening; University of Hertfordshire. Wednesday, 30 April 2014: The nature of dispensing errors in hospital pharmacies (Presentations)

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Appendices

Appendix 1: University of Hertfordshire Research Ethics Committee

Appendix 2: KSMC Ethics Approval

Appendix 3: Approval was obtained from the Luton and Dunstable Hospital

Appendix 4: KSMC Medication Errors Form

Appendix 5: L&D Incident Report Form (Datix)

Appendix 6: Data Collection Form for Medication Errors

Appendix 7: Data Collection Form for Dispensing Errors

Appendix 8: Assessment of Dispensing Error Severity Form

Appendix 9: Questionnaires Forms

Appendix 1: University of Hertfordshire Research Ethics Committee

UNIVERSITY OF HERTFORDSHIRE
HEALTH AND HUMAN SCIENCES

M E M O R A N D U M

TO **Khalid Aldhwaihi**

CC **Nkiruka Umaru**

FROM Dr Richard Southern, Health and Human Sciences ECDA Chairman

DATE **28 October 2013**

Protocol number: LMS/PG/UH/00086

Title of study: An evaluation of the types and contributing factors of dispensing errors in hospital pharmacies: a comparative study.

Your application for ethical approval has been accepted and approved by the ECDA for your school.

This approval is valid:

From: 28 October 2013

To: 31 October 2015

Please note:

Approval applies specifically to the research study/methodology and timings as detailed in your Form EC1. Should you amend any aspect of your research, or wish to apply for an extension to your study, you will need your supervisor's approval and must complete and submit form EC2. In cases where the amendments to the original study are deemed to be substantial, a new Form EC1 may need to be completed prior to the study being undertaken.

Appendix 2: KSMC Ethics Approval

Kingdom of Saudi Arabia
Ministry of Health

مدينة الملك سعود الطبية
KING SAUD MEDICAL CITY

المملكة العربية السعودية
وزارة الصحة

Date: *June 15, 2013*

TO WHOM IT MAY CONCERN

Dear Mr. Aldhwaihi ,

Thank you for your letter seeking the approval to collect data from King Saud Medical City (KSMC). I would like to confirm that you have received the approval from the research committee to collect the data for your project titled "An evaluation of the types and contributing factors of dispensing errors in hospital pharmacies" in collaboration with the research team (Pharmacists) from KSMC: Ph/ Ibrahim Azaaaqa -Director of pharmaceutical care and medication safety supervisor, Ph/ Dalal Al-Dosari-Coordinator of medication errors and Ph/ Sarah Salem, between the periods covering August 2013 to February 2014.

Sincerely yours,

Dr. Rafah Saleh Al yousef
Director, Academic & Research Affairs
King Saud Medical City
Riyadh, Saudi Arabia

المرفقات ..... التاريخ ١٤٣٤/٨/١٠ الرقم ٤٢١١٣

Appendix 3: Approval was obtained from the Luton and Dunstable Hospital

From: Randell William (RC9) Luton & Dunstable Hospital TR [mailto:William.Randell@ldh.nhs.uk]
Sent: 16 October 2013 13:13
To: Pezzolesi, Cinzia
Subject: RE: Khaled

Hi,
When I came back from AL I had over 2000 emails to look at, this will be why something's got missed.

However:

I am happy with Khaled Aldhwaihi to conduct his research project at the L&D hospital

Any queries please call

William

William Randell
Head of Risk and Governance
Luton and Dunstable NHS Foundation Trust Hospital
(: 01582 718015
Mob: 07786110137
9: William.randell@ldh.nhs.uk
william.randell@nhs.net (secure)
https://www.ldh.nhs.uk/default.htm

From: Pezzolesi, Cinzia [mailto:c.pezzolesi@herts.ac.uk]
Sent: 16 October 2013 12:30
To: Randell William (RC9) Luton & Dunstable Hospital TR
Subject: FW: Khaled
Thank you!!
From: Pezzolesi, Cinzia
Sent: 03 October 2013 09:42
To: 'Randell William (RC9) Luton & Dunstable Hospital TR'
Cc: Schifano, Fabrizio; Umaru, Nkiruka; Aldhwaihi, Khaled Abdulrahman A
Subject: Khaled

Dear William,

I hope you are well. I am very sorry to disturb you again but Khaled (our PhD student) will start his data collection at the L&D soon and we are working on his ethics application.
Would you mind sending us a line in which you say that you are happy with Khaled to do his project at the L&D. I think you have done this before but somehow we cannot find the email. It could be something like 'I am happy with Khaled Aldhwaihi to conduct his research project at the L&D hospital'.

Many thanks for your help

Regards
Cinzia

From: Hardy Diana (RC9) Luton & Dunstable Hospital TR
To: Umaru, Nkiruka
Cc: Aldhwaihi, Khaled Abdulrahman A; Geeson Cathy (RC9) Luton & Dunstable Hospital TR; Edwards Patricia (RC9) Luton & Dunstable Hospital TR
Subject: RE: Ethics approval
Date: 05 December 2013 15:42:56
Attachments: 1. Defining Research Leaflet[1].December 2009.pdf

Dear Nikkie,
Thank you for your email and since UH Research Sponsorship has advised that you do not require NHS ethics approval you do not require R & D approval. If the study does not require Research Ethics Committee approval by definition the study cannot be defined as research - that is a contradiction in terms. Please see attached. I would think the study should be classed as Service Evaluation. If the study were to be defined as 'research' it would need Research Ethics Committee approval (plus R & D approval).

However, if Pharmacy agree to this project taking place in their Department then they will arrangefor the Honorary Contract.

Kind regards.
Diana
Diana Hardy
Research & Development Manager
Luton and Dunstable University Hospital NHS Foundation Trust
Lewsey Road
Luton LU4 0DZ
Tel: 01582 718243
Fax: 01582 718244
Email: diana.hardy@ldh.nhs.uk
----Original Message-----

From: Umaru, Nkiruka [mailto:n.e.umaru@herts.ac.uk]
Sent: 05 December 2013 14:40
To: Hardy Diana (RC9) Luton & Dunstable Hospital TR; Geeson Cathy (RC9) Luton & Dunstable Hospital TR
Cc: Aldhwaihi, Khaled Abdulrahman A
Subject: RE: Ethics approval

Dear Diana,

Many thanks for your reply to my PhD student's query. We intend to arrange a meeting with Cathy and/or Mary to obtian their support to undertake the study. The study will retrospectively review the Datix database mainly for errors related to medication and also conduct a qualitative survey online with those invovled with disppensing within the pharmacy team. We have the support of William Rendall which was a requisite to obtain UH ethics approval. This study is classified as research not audit and in addition we do not need NHS approval because it does not involve patients, just NHS staff as confirmed by NHS REC office.
Khaled will require authorisation and an Honorary contract in order to review the database and conduct his survey, however, please let us know if we still need to apply for R&D approval.
Kind regards
Nikkie

Please see excerpt below
Dear Khaled,
We have been advised by UH Research Sponsorship that your study entitled 'An evaluation of the types and contributing factors of dispensing errors in hospital pharmacies: a comparative study' does not require NHS ethics approval.

If you still intend to conduct this study you are required to obtain UH ethics approval. The protocol number issued has not been validated and you must not commence participant recruitment or data collection for this study until UH ethics approval is granted.
Please discuss this with your supervisor and, should you wish to continue with this study, please arrange for your supervisor to resubmit your completed EC1 application form and any relevant appendices to hhsecda@herts.ac.uk . Your application will be considered by the UH ethics reviewers and their response will be sent to you in due course. Here is the link to all the relevant paperwork http://sitem.herts.ac.uk/secreg/EthicsFormsGuidanceNotes.htm. I have attached your original partcompleted EC1 for reference for you.

If you require further clarification regarding this matter, please contact us.

Kind regards,
Lesley Powell
Ethics Clerk
Academic Services
MacLaurin Building
de Havilland Campus
University of Hertfordshire
Ext - 1254
ECDA email addresses:
Health & Human Sciences - hhsecda@herts.ac.uk Science & Technology - stecda@herts.ac.uk Social Sciences, Arts & Humanities - ssahecda@herts.ac.uk
-----Original Message-----

From: Aldhwaihi, Khaled Abdulrahman A
Sent: 26 June 2013 09:06
To: hhsecda, uh
Subject: FW: internal protocol number

Hi Dear,
Can I have a internal protocol number. I have attached all required document.

Best regards
Khaled

From: Aldhwaihi, Khaled Abdulrahman A
Sent: 24 June 2013 08:01
To: hhsecda, uh
Subject: internal protocol number

Hi Dear,
I am a PhD student and I am in the ethics approval process. I am wondering if I can have a internal protocol number.

Please find all required document attached.

Best regards,
Khaled Aldhwaihi
Dr Nkiruka Umaru (Nikkie)
Department of Pharmacy, School of Life and Medical Sciences University of Hertfordshire, College Lane, Hatfield, Herts AL10 9AB
Tel: 01707 286519 (Int: 3519); E-mail : n.e.umaru@herts.ac.uk

---

From: Hardy Diana (RC9) Luton & Dunstable Hospital TR [Diana.Hardy@ldh.nhs.uk]
Sent: Thursday, December 05, 2013 10:55 AM
To: Geeson Cathy (RC9) Luton & Dunstable Hospital TR
Cc: Aldhwaihi, Khaled Abdulrahman A; Umaru, Nkiruka
Subject: FW: Ethics approval

Dear Cathy,

Are you aware of this request from Khaled Aldhwaihi? I'm sure he hasn't got Research Ethics Committee (REC) approval since the University of Hertfordshire is not a REC approved site. However, I believe he means he has his University's ethical approval which is quite different. It would also appear, although I have very little information other than that written below, that this project is not research i.e. he states that this is an 'evaluation'. If it is not research he will not require REC or R & D approval to undertake the study on site. He would require your authorisation and an Honorary Contract to come on site. I believe you deal with many students from the University of Hertfordshire wishing to undertake such projects in your Department.

However, if the study is indeed defined as research, I can send Khaled all the information on how to define his study and how to apply for both Research Ethics Committee and R & D approvals. However, it would still need authorisation from the Pharmacy Department.

I look forward to hearing from you please.

Many thanks.

Best wishes.

Diana
-----Original Message-----

From: Aldhwaihi, Khaled Abdulrahman A [mailto:k.aldhwaihi@herts.ac.uk]
Sent: 05 December 2013 10:41
To: Hardy Diana (RC9) Luton & Dunstable Hospital TR
Cc: Umaru, Nkiruka
Subject: Ethics approval

Dear Diana,

Hope you are well.

I am Khaled Aldhwaihi, a PhD student at the Pharmacy Department, University of Hertfordshire. My research project is about (An evaluation of the types and contributing factors of dispensing errors in hospital pharmacies). To conduct my study, I am planning to review retrospectively the dispensing errors reports at L&D Hospital. Also, I will distribute Questionnaire to be completed by the pharmacists in the hospital. The ethical approval has been obtained from REC at the University of Hertfordshire. Based on an advice from the REC at NHS I need to have the R&D approval from L&D Hospital to commence my study.

I would be grateful if you let me know how to apply for the R&D approval and what documents are required.

Thanks & Regards,

Khaled

Appendix 4: KSMC Medication Errors Form

King Saud Medical City

Medication Safety Unit

MEDICATION ERROR REPORT FORM

(Please fill all application information)

1.	**Date when events occurred (/Day/ Month/ Year)**
2.	**Time of events:**
3.	**Report date (Day/Month/Year)**
4.	**Diagnosis:**
5.	**Brand and Generic Name** _____ **Drug strength**_____ **Dosage form**_____ **Route of administration** _____
6.	**Where did the initial error occurred:**
7.	**Type of Error: (Select only one)** - Omission error - Wrong dosage form - Improper dose (over, under or extra dose) - Wrong time of administration - Wrong patient - Deteriorated / Expired technique - Wrong drug - Deteriorated / Expired medication - Wrong strength/ concentration - Monitoring error-Clinical intervention or information - Wrong route - Monitoring error-Drug-drug interaction - Wrong frequency - Monitoring error-Drug Food Interaction - Wrong rate of Infusion - Monitoring error-Drug-disease Interaction - Wrong duration - Others.....
8.	**Stage(s) involved: (May select more than one)** - Physician ordering and entering process - Dispensing and Delivery - Administration process - Monitoring (drug Level/allergy/interaction/clinical) - Transcription - Others.....
9.	**Description of error: (circumstances relating to the event. All information from the beginning to the resolution of event,**
10.	**How event discovered?**
11.	**Used by Patient:** □ **Yes** □ **No**
12.	**Outcome: (Select only one)** _____(A) Circumstances/ events with capacity to cause error. (Index 1) _____(B) Error occurred but did not reach the patient. (Near miss) _____(C) Error occurred but did not cause harm. (Index 1) _____(D) Error reach the patient & required monitoring. (Index 2) _____(E) Error reach the patient & result in temporary harm & required intervention. (Index 3) _____(F) Error reached the patient & result in permanent patient harm. (Index 4) _____(G) Error reached the patient & required intervention necessary to sustain life. (Index 4) _____(H) error reached to the patient & contributed to the patient's death . (Index 4) **N.B (Index 4) immediately notify the sentinel event committee**
13.	**Error made by: (Who initiated the error)** _____MD/ Physician _____Dentist _____Pharmacist _____Patient/Caregiver _____Others..... _____Nurse _____Technicians (Radiology, OR,RT , lab , pharmacy)
14.	**Error reported by:** _____MD/ Physician _____Dentist _____Pharmacist _____Patient/Caregiver _____Others..... _____Nurse _____Technicians (Radiology, OR,RT. pharmacist)

15. Was error perpetuated (repeated?) □ Yes □ No
(If Yes , explain)……

16. Cause of error/ Contribution factor: (May choose more than one)

1. Clinical information missing (Lab results or vital signs)
2. Drug information missing .
3. Miscommunication of drug order (illegible, ambiguous, incomplete),
4. Look alike and sound alike medication problem .
5. Drug name, label, filling and package problem
6. Drug storage or delivery problem.
7. Drug delivery device problem .
8. Environmental ,staffing deficiency and workload problem .
9. Lack of staff education and training problem .
10. Patient education problem .
11. Independent double check system .
12. **Others (Please specified)**……

17. Action taken for resolution (For Pharmacists or Nurses):

1 . Call physician for verification for emergency order
2 . Clinical intervention
3. Education & trained medical staff
4. Send pharmacist note to physician for clarification
5. Change to correct dose,
6. perform root cause analysis
7. Discontinue one drug (improper combination)
8. Return drugs to pharmacy
9. drug not dispense to the patient_
10 . Memo send to department.
11. (if other please mention)……

18. Intervention action taken for resolution (For physicians) : (IF NEEDED)

1. Testing
2. Additional observation
3.Give antidote
4. Care escalated
5. Additional LOS
6 Change to correct drug ,dose ,frequency , duration
7 Others……

19. Recommendation: (Suggestion on how to prevent recurrence of this error)

Please send completed form to
Medication safety unit
Tel, No. 014355555 Ext. 1999 or 1201
Fax No. 014351777

Appendix 5: Incident Report Form (Datix)

Incident Report Form

You do not need to login to complete and submit the incident form

The accurate, open reporting of accidents, errors or near misses makes a significant contribution to promoting quality Healthcare. Completion of the incident form will not lead to disciplinary action, except where acts or omissions are malicious, criminal, or constitute gross or repeated professional misconduct. Please refer to the Policy for Incident Reporting.

To be able to learn how to complete the form click this link DatixWeb reporting guide.

Incident details
Please fill in all details and a red star indicates the field is mandatory

* **What type of incident occurred?**	**Clinical related incidents**
* **Incident date** (dd/MM/yyyy)	
Time (hh:mm) hh:mm Please enter time in 24 hourly format e.g 1pm is 13:00hrs	
* **Division** incident related to.	
* **Specialty** incident related to.	**Pharmacy Department**
* **Exact Location of incident**	**Pharmacy**
* **Description of incident** Please enter facts only **Personal Identifiable information to be entered into the Additional Information section below**	
* **Action taken** Please state what immediate action was taken. Please state any Medical Treatment, if given. Please state who was informed of this incident. **Also state if there were any steps taken before this incident e.g Care plans etc to help prevent this incident**	

Notify
To whom was the incident notified.
Click the green plus button and select.

Incident Coding
This is optional

Category **Drug**

Subcategory **Dispensing/prescribing/administration**

Incident Severity
Severity field - this is mandatory

*** Severity**

Risk grading
Risk Grading Matrix.

Consequence: Choose

Likelihood: Choose

Grade:

Additional Information
Please state yes or no to each field here. If selected yes please fill in details futher down below.

*** Was any person/patient involved/affected by this incident** Choose

*** Others Involved** Choose
This includes Medical Staff or nursing staff AHP and Non-Clinical staff.

*** Was any equipment involved in the incident?** Choose

*** Was this a medication incident?** Choose

Are there any documents to be attached to this record? ☐
Please send any paper statements to Risk Management with the 'W' reference number to be scanned and saved to this incident.

Details of person reporting the incident
Please enter your first name and surname to enable a thorough investigation.
Feedback - Your incident form will be forwarded electronically to designated staff in your Directorate.
For Low and Medium rated incidents they will provide feedback.
For High related incidents feedback will be via the Directorate or the Risk Manager.
If you have not received feedback please contact your line manager in the first instance.

Reporter **Clear Section**

Job Title

Title

First names

Surname

E-mail
Hospital email only.
firstname.lastname@ldh.nhs.uk

Telephone number/extension

Submit Submit and print Cancel

(Appendix 6) Form 1 - Medication Errors Data Collection Form

No.	Date of incident	Drug				Description of error	Type of M.E
		Name	Strength	Route	Form		
							☐Prescribing ☐Dispensing ☐Administration ☐Monitoring ☐Transcribing Other…………..
							☐Prescribing ☐Dispensing ☐Administration ☐Monitoring ☐Transcribing Other…………..
							☐Prescribing ☐Dispensing ☐Administration ☐Monitoring ☐Transcribing Other…………..
							☐Prescribing ☐Dispensing ☐Administration ☐Monitoring ☐Transcribing Other…………..
							☐Prescribing ☐Dispensing ☐Administration ☐Monitoring ☐Transcribing Other…………..
							☐Prescribing ☐Dispensing ☐Administration ☐Monitoring ☐Transcribing Other…………..
							☐Prescribing ☐Dispensing ☐Administration ☐Monitoring ☐Transcribing Other…………..

(Appendix 7) Form 2 – Dispensing error Data Collection form

No	Date of incident	Drug				Description of dispensing error	Type of D.E (code)
		Name	Strength	Route	Form		

Appendix 8: Assessment of Dispensing Error Severity Form

Assessment of Dispensing Error Severity

Thank you for your agreement to be a member of our expert panel to assess dispensing errors detected in hospital pharmacies. Assessment the severity of dispensing errors is a part of my (Khaled Aldhwaihi) PhD work under the supervision of Dr Nkiruka Umaru, Professor Fabrizio Schifano and Dr Cinzia Pezzolesi at the Department of Pharmacy, University of Hertfordshire.

The PhD study aims to determine the nature and severity of dispensing errors reported in the hospital pharmacies at King Saud Medical City (KSMC) hospital in Saudi Arabia, and at Luton and Dunstable Hospital (L&D) NHS Foundation Trust in the UK. The research consists of two phases; Phase 1 involves identifying types of dispensing errors and assessing their severity. This phase had been done through retrospective review of incident reports in the two hospitals and then using an expert panel to assess the severity of dispensing errors. Phase 2 investigates factors contributing to dispensing errors and how to reduce these errors throw quantitative questionnaires.

The study used the following definition of a dispensing error *"any unintended deviation from an interpretable written prescription or medication order including content and labelling errors; any unintended deviation from professional or regulatory references, or guidelines affecting dispensing procedures, is also considered a dispensing error"* (Franklin and O'Grady, 2007) in the pharmacy departments. There are two dispensing errors types, prevented dispensing error and unprevented dispensing error.

Prevented dispensing error: the errors identified before the medication has left the pharmacy department.

Unprevented dispensing error: the error detected after the medication has left the pharmacy department

You have been chosen as member of expert panel to assess the severity of the identified unprevented dispensing errors. The expert panel comprises three judges with previous experience in dispensing errors. Each member will be asked to use this form to classify the potential risk of patient harm from the identified unprevented dispensing errors.

Please rate the following error scenarios and classify for potential risk of patient harm using the classification description provided below (James, 2011). The errors presented have all been considered as unprevented dispensing errors.

Catastrophic This could have resulted in death.

Major These could have caused major permanent harm or an increased length of stay in hospital or increased level of care for more than 15 days.

Moderate These incidents could have caused semi-permanent harm (up to 1 year) or an increased length of stay in hospital or increased level of care for up to 15 days.

Minor This includes incidents that could have resulted in non-permanent harm (up to 1 month) or an increased length of stay in hospital or increased level of care for up to 7 days

None No harm could have resulted.

Please note that although these dispensing errors were identified retrospectively, there is limited information on patient details, potential influencing factors which may have contributed to the error and patient outcome following the error due to the limitations of the error reporting database used. However, all errors occurred in the pharmacy dispensary. We ask that you classify the following errors for potential severity level. You can provide a note as to why you have chosen the option you have given the particular error in the assessment justification box. An example is provided below as a guide.

DE Ref	Dispensed Medicine	Type of Dispensing errors
00001	Lamotrigine 100mg tablet	Dispensed Lamotrigine 100mg tablet instead of Labetalol 100mg tablet
More information	None available	
Severity of incident	**None** ☐ **Minor** ☐ **Moderate** ■ **Major** ☐ **Catastrophic** ☐	
Assessment justification	Moderate harm assigned due to the effects of Lamotrigine (starting dose usually 25-50mg Daily). Severity rating could be raised to Major given certain contexts e.g. more than a few doses and/or if patient was pregnant / breastfeeding.	

DE Ref	Dispensed Medicine	Type of Dispensing errors
78764	Moxifloxacin 400mg tablet	Dispensed Moxonidine 200mg instead of Moxifloxacin 400mg
More information	None available	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
78973	PEG interferon alfa 120mcg (IV)	Dispensed and labelled as PEG interferon alfa 150mcg
More information	Out-patient prescription	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
78974	N-acetylcysteine 1.2gm tablet	Dispensed and labelled as Sodium Chloride 1.2gm
More information	None available	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
81164	Clobetasone skin ointment	Dispensed as Dermovate instead of Clobetasone
More information	Children's out-patient prescription	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
81677	Midazolam Buccal 5mg (IV)	Labelled as Midazolam Buccal 1ml (10mg) instead 0.5ml (5 mg)
More information	Child	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
82495	Clonazepam 0.25mg tablet	Dispensed and labelled as Clonidine 25mcg
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
More information	Patient had taken 4 doses of incorrect medication	
Assessment justification		
85395	Enoxaparin 20mg (SC)	Dispensed as Enoxaparin 40mg
More information	In-patient	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
82282	Ceftriaxone IV	Dispensed as Ceforoxime IV (wrong drug)
More information	The first dose administrated to the child by community nurse	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
85390	Mesalamin (Asacol®)	Dispensed as Mesalazine (Pentasa®)
More information	None available	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		

DE Ref	Dispensed Medicine	Type of Dispensing errors
85498	Hydroxyzine 25mg	Dispensed and labelled as Hydralazine 25mg
More information	In-patient	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
94698	Aquacel AG Ribbon	Dispensed and labelled as Aquacel Ribbon
More information	Ward used the plain Aquacel Ribbons over the weekend	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
79442	Morphine 2.5ml	Labelling wrong dose as Morphine 5ml
More information	The error identified by nursing home	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
85399	Dexamethasone 1ml amp.	Labelling wrong dose as Dexamethasone 1.2ml
More information	Child patient (In-patient)	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
94697	Morphine Sulphate SR 10mg	Dispensed as Morphine Sulphate SR 100mg
More information	Discharge patient	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
92720	Mycophenolate 250mg	Dispensed Mycophenolate 500mg
More information	Discharge patient	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
80731	Bimatoprost 0.01%	Labelled wrong concentration as Bimatoprost 0.03%
More information	In-patient	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
90974	Ranitidine injection	Dispensed Ranitidine oral instead of Ranitidine injection
More information	None available	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
86640	Methotrexate	Labelling the wrong expiry date of Methotrexate 21/12/2012 instead of 28/9/2012
More information	Outpatient prescription- the error discovered by the patient	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		

DE Ref	Dispensed Medicine	Type of Dispensing errors
91054	Fentanyl	Dispensed the wrong quantity of Fentanyl 10 ampoules instead of 20 ampoules
More information	None available	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
94362	Morphine	Dispensing the wrong quantity of Morphine 100mls instead of 500mls
More information	The error identified by nurse	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
92121	Etoposide	Omission of Etoposide capsules (did not dispensed for the patient)
More information	None available	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
92048	Methotrexate 15mg	Dispensed wrong dose as Methotrexate 5mg
More information	The error identified by nurse	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
92901	Sodium chloride 9% eye drop	Dispensed wrong concentration as Sodium chloride 5% eye drops
More information	None available	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
94502	Epoetin alfa 10000 units	Dispensed wrong concentration as Epoetin alfa 6000 units
More information	The error identified by nurse	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
81636	insulin	Insulin baggage labeled by a complete wrong label
More information	None available	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
82805	Flucloxacilline	Flucloxacilline vial labeled by a complete wrong label
More information	None available	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
83023	Carbocisteine capsul	Incomplete information in the label
More information	No clinical directions on how to take the medicine	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		

DE Ref	Dispensed Medicine	Type of Dispensing errors
85606	TPN preparation	Labelling the wrong patient name
More information	In-patient	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
91717-91714	Cetuximab	Labelling the wrong patient name for Cetuximab
More information	None available	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
94652	Lamotrigine	Labelling the wrong patient name for Lamotrigine
More information	None available	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
85674	Paracetamol 250mg/5ml	Labelling the wrong instructions, two 5ml instead of 5ml
More information	None available	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
86555	Cyclizine 50mg/1ml inj.	Dispensed wrong formulation as Cyclizine 50mg tablets
More information	The error identified by a nurse	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
83226	Candesartan 16mg	Dispensed and labelled for wrong patient
More information	In-patient	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
83227	Sotalol 40mg	Dispensed and labelled as Sotalol 80mg
More information	In-patient	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
85748-85781	TPN preparation	Incomplete information in the label (no patient name)
More information	In-patient	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		
89827	Buprenorphine 52.5 patch	Dispensing the wrong quantity 4 patch instead 5 patch
More information	None available	
Severity of incident	**None ☐** **Minor ☐** **Moderate ☐** **Major ☐** **Catastrophic ☐**	
Assessment justification		

DE Ref	Dispensed Medicine	Type of Dispensing errors
93389	Sodium bicarbonate 1.26% IV	Dispensing an expired medicine
More information	The medicine was not administrated to the patient	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
1330113-1610213 1700213	Dexamethasone 0.5mg tablet	Dispensed as Methyldopa 250mg (the patient took the medicine)
More information	Out-patient, the error identified by the patient	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
3140113	Mesalazine 400mg tablet	Dispensed as Mesalazine suppository instead tablet
More information	The error identified by a nurse before administering the dose to the patient	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
4420213	Omeprazole 40 mg vial	Dispensed wrong quantity, 20 vials for inpatient instead 2 vials
More information	The error identified by a nurse	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
330313	Amlodipine 5mg	Dispensed and labelled as Amlodipine 10mg instead 5mg
More information	The error identified by the patient; the patient took the medicine	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
170613	Epinephrine injection	Did not dispensed the dose for the in-patent (omission dose)
More information	The error identified by a nurse	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
1960613-1970612	Fat emulsion injection	Dispensed as Vitalipid injection
More information	The error identified by a nurse	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
510112	Fluticasone inhaler	Dispensed fluticasone+salmeterol inhaler instead of Fluticasone
More information	The medicine was taken by the patient and the physician discovered the error in the next appointment	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
200212	Vancomycin 500mg vial	Dispensed Cefuroxime 750mg vial instead of Vancomycin 500mg
More information	The error identified by a nurse	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		

DE Ref	Dispensed Medicine	Type of Dispensing errors
1500712	Calcium carbonate 500mg	Dispensed Sodium bicarbonate 375mg instead of Calcium carbonate 500mg
More information	The error identified by the patient and he did not take the medicine	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
620812	Prednisolone 5mg tablets	Dispensed Perindopril 5mg instead of Prednisolone 5mg
More information	The error identified by the patient and he took the medicine	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
1540112	Paracetamol 500mg	Dispensed Calcium carbonate 500mg instead of Paracetamol
More information	The patient took two doses of the medicine (in-patient)	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
430812	Nifedipine 20mg tablets	Dispensed and labeled Nifedipine 10mg instead of Nifedipine 20mg
More information	The patient took the medicine and the error identified by a pharmacist when the patient returned for a repeat prescription (refill)	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
340812	Mesalazine 500mg	Dispensed Mesalazine 1gm suppository instead of Mesalazine 500mg for in-patient
More information	The error identified by the patient and he took the medicine	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
270912	Simvastatin 40mg	Dispensed Simvastatin 10mg instead of Simvastatin 40mg
More information	The patient took the medicine and the error identified by a pharmacist when the patient returned for a repeat prescription (refill)	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
840613	Paracetamol 500mg tablet	Dispensed Paracetamol vial instead Paracetamol tablet
More information	The error identified by a nurse	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		
760212	Cyclosporine 100mg capsule	Dispensed expired Cyclosporine capsule for in-patient
More information	The error identified by a nurse	
Severity of incident	**None ☐ Minor ☐ Moderate ☐ Major ☐ Catastrophic ☐**	
Assessment justification		

Expert Panel name:

Appendix 9: Questionnaires Forms

An Exploration of the Factors Associated with Dispensing Errors and Strategies for Reducing Them

(Information Sheet)

We would like to invite you to take part in our research study. Before you decide whether to do so, we would like you to understand why the research is being carried out and what it would involve for you.

This research will form the basis of Mr Khaled Aldhwaihi's doctoral degree. Its purpose is to identify the nature of dispensing errors in hospital pharmacies at King Saud Medical City (KSMC) in Saudi Arabia and at the Luton and Dunstable Hospital NHS Foundation Trust (L&D) in the UK. As such it seeks to explore the factors associated with dispensing errors and recommendations to reduce occurrence of these errors.

Dispensing errors can occur at any stage of the dispensing process, which starts from receipt of the prescription from a patient and ends with the distribution of the medicine to the patient or the patient's representative. The study has adopted the following definition of a dispensing error: *'any unintended deviation from an interpretable written prescription or medication order including content and labelling errors; any unintended deviation from professional or regulatory references, or guidelines affecting dispensing procedures, is also considered a dispensing error'* (Franklin and O'Grady, 2007).

The project consists of two phases, each of which uses a different methodological approach. In phase one the quantitative approach has been conducted to investigate the factors associated with dispensing errors. In phase two a qualitative approach will be used. The quantitative phase has already been completed through a retrospective review of incident reports at KSMC and L&D for an 18-month period that ranged from 1 January 2012 to 30 June 2013. However, the qualitative phase needs the kind cooperation of participants who are being asked to complete a qualitative questionnaire. That process will take around 15-20 minutes. Your participation is very important for this research, as it will provide the researcher with more details about dispensing error issues; it will also enable you to share your views and your experience as well as your ideas for reducing dispensing errors.

Confidentiality will be guaranteed to all participants and maintained throughout the project. All participants' personal data and comments will be treated confidentially and will be anonymised in any future publications. There will be no further obligation on your part. Completing the questionnaire will be considered as your implied consent to participate in the study.

This research is closely supervised by Dr Nkiruka Umaru, Prof. Fabrizio Schifano and Dr Cinzia Pezzolesi at the Department of Pharmacy, University of Hertfordshire. If you have any concerns about the questionnaire, or want further information about the study, please contact one of the research team:

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Summary of retrospective study on dispensing error incidents reported at KSMC:

A total of 637 dispensing error incidents were reported at KSMC from January 2012 to June 2013. Of these 637 incidents, 617 dispensing error cases (96.9%) were intercepted before the medicine left the pharmacy department. However, the remaining 20 dispensing error cases (3.1%) went undetected before the medicine left the pharmacy. The most frequently reported dispensing errors were: dispensing the wrong medicine (n = 323/637, 50.7%), dispensing the wrong strength (n = 128/637, 20.1%) and incorrectly labelling the medicine strength (n = 89/637, 14%). For example, some of the most frequently reported errors were: dispensing Tenofovir instead of Truvada® (n=30) and dispensing Cinacalcet 30 mg instead of Cinacalcet 60 mg (n=24), or vice-versa.

(Questionnaire)

Please complete the following questions:

Section One: Questions About Yourself

1.1 What is your current job role?

☐ Pharmacist ☐ Pharmacy Technician

☐ Other, please specify .....

1.2 Are you involved in preparing/dispensing medicines in the pharmacy department?

☐ Yes ☐ No

If **NO,** thank you for completing this questionnaire and sending it back, your response is very important to us.

Section Two: Dispensing Errors.

2.1 What are the current procedures followed in your pharmacy department to reduce dispensing errors?

2.2 Our quantitative study findings indicate that the most common dispensing error types were 'dispensing the wrong medicine' and 'dispensing the wrong strength'. In your opinion, why are these dispensing errors common in your hospital?

2.3 From your experience, can you list any contributing factors associated with these errors in your hospital?

2.4 What procedures do you think should be followed to reduce these errors?

2.5 Please list the main contributing factors that are involved in causing any types of dispensing errors in general during the dispensing process in your hospital?

2.6 What recommendations would you suggest to reduce dispensing errors in general in your hospital?

2.7 Are you satisfied with the medication error reporting system in your hospital? Why?

2.8 What actions are usually taken to learn from reported dispensing errors to prevent them happening again?

2.9 Do you have any further comments or suggestions on any issues related to dispensing errors?

Thank you for taking the time to complete this questionnaire.