Kwame Nkrumah University of Science & Technology,

Kumasi

EVALUATING THE ROLE OF THE GHANAIAN PHARMACIST IN MEDICATION SAFETY STRATEGIES IN HOSPITALS

A THESIS SUBMITTED IN FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

In the

Department of Clinical and Social Pharmacy,

Faculty of Pharmacy and Pharmaceutical Sciences

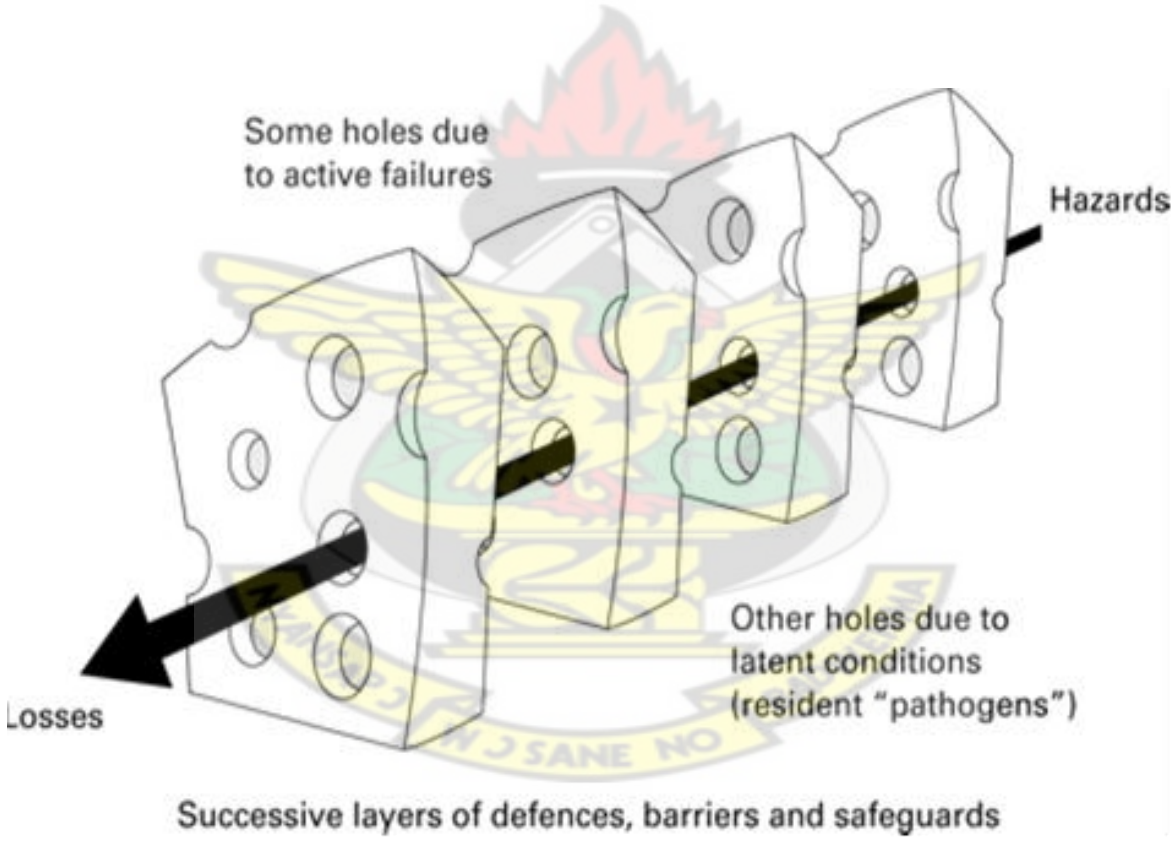
College of Health Sciences

by

FRANKLIN ACHEAMPONG

SEPTEMBER, 2014

EVALUATING THE ROLE OF THE GHANAIAN PHARMACIST IN MEDICATION SAFETY STRATEGIES IN HOSPITALS



by

FRANKLIN ACHEAMPONG

Declarations

I, Franklin Acheampong, declare that this is my original work and it has not been submitted to any other institution for any award. All cited works have been duly referenced appropriately.

……. _____

FRANKLIN ACHEAMPONG DATE

STUDENT (I.D: 20291870)

……. _____

DR BERKO PANYIN ANTO DATE

SUPERVISOR

CERTIFIED BY

…….…. _____

DR K. O. BUABENG DATE

(HEAD OF DEPARTMENT)

Dedication

To Victoria, Acelynn Ashanti and Iain Franklin.

Acknowledgement

I can only begin by singing *'To God be the glory, great things He has done'*. I am forever grateful to God for life, good health, sound mind, strength and good support to complete this work on schedule. I thank Him for revealing his scripture in Proverbs 6:4; which was my guiding principle during the study period.

Dr Berko Anto, thank you, certainly for sharing your knowledge, mentoring me, challenging me, pushing me, and step and step guiding me through this process, and most importantly for keeping me on track, and on schedule. Your time consciousness was overwhelmingly encouranging. Your corrections were heavenly sent and made me a better writer. I am also grateful for exposing my work to the world through our publications and I look forward to a life-long of mentorship as I continue to learn from your rich experience. I cannot forget your constant reminder as you kept saying "You will finish, you will finish". Special thanks also go to the Head of Department, Clinical and Social Pharmacy, Dr Kwame Buabeng for his support and timely contributions to the work.

I am very grateful to my wife, Victoria and children Acelynn and Iain (Jnr) for the love, understanding, prayers and care. I didn't have to explain too much my absence from home to see to my work. During those return flights and endless nights, you were the reasons for the energy and drive. I am highly indebted to my dad (Ben), who set this academic path for me, and to my brothers, Prince (Sabuto), Bernard (Rev) and sisters, Cynthia (Yaa Baby) and Pharm Doreen, I appreciate your support.

Finally, to a colleague, a friend, Samuel O Bekoe (*Sobek)*, who gave a listening ear as we shared our PhD experiences together to the end.

Abstract

Background

Healthcare has always been a risky venture with a lot of harm associated with it. Medicines form a major and vital part of the healthcare delivery system. The World Health Organisation and many national safety organisations have created a lot of awareness about the importance of enhancing patient safety in the healthcare system. Evidence available suggests that a lot of adverse drug events especially medication administration errors occur during the medication use process. Consequently, it is important to detect and prevent errors at the drug administration stage, since it is also the last step before these errors could reach patients. In Ghana, little is known of the prevalence and contributory factors of medication administration errors. Current literature suggests the existence of many medication safety strategies that are being employed. Pharmacists in particular, have been identified to contribute immensely to the safe use of medicines globally. The aim of this study was to determine the existence of adverse drug events with emphasis on medication administration errors, explore the perceived roles and documented evidences of pharmacists' roles in the safe use of medicines and understand the experiences and expectations of doctors and nurses on such roles.

Methods

The methods used were the following:

- A direct non-participatory observation of medication administration by nurses followed by face-to-face interview with a sample of these nurses at the Surgical Medical Emergency Department of Korle Bu Teaching Hospital.
- Survey of pharmacists working in Ghanaian hospitals across the country using a structured questionnaire.
- Retrospective evaluation of documented clinical intervention reports followed by key informant interviews of pharmacists involved in the reporting.
- Open and close-ended questionnaires administered to a conveniently sampled doctors and nurses at the hospital to explore their perceptions and expectations.

Key findings

- Medication administration errors occurred at a rate of 27.2% at the emergency setting. It was also shown that most of the causes of the errors were related to staff and environmental factors such as workload, and lack of adequate knowledge about medication and their use.

- Pharmacists in Ghanaian hospitals perceived their services to be useful in preventing adverse drug events. They indicated that they spent more time on activities with perceived greatest impact on patient care such as reviewing pharmacotherapies, monitoring adverse drug reactions and counselling patients on medication use.

- Documented evidence of Pharmacist's clinical interventions activities revealed that 24 pharmacists made 1019 clinical interventions in 448 handwritten reports. Majority (76.1%) of the interventions related to drug therapy changes. The pharmacists reported that the major barrier to their medication safety roles was the perceived discrepant attitude of doctors and nurses.

- In contrast, doctors and nurses indicated that they interacted frequently with pharmacists and acknowledged their roles to be useful in contributing to medication safety.

Conclusions and Recommendations

- Medication administration errors were observed in over a quarter of the activities of the nurses involved in the study.

- There was an overwhelming evidence of the strategic role of hospital pharmacists in identifying and preventing adverse drug events.

- Unlike the perception that pharmacists had about the discrepant attitudes of doctors and nurses, the clinicians acknowledged and appreciated the role of the pharmacist in medication safety.

- The clinical role of pharmacist in hospitals should be intensified to enhance safety and patient care.

Table of Contents

List of Tables

List of Figures

List of Appendices

Glossary and terms

ACSQH	Australian Council for Safety and Quality in Health
ADE	Adverse Drug Event
ADR	Adverse Drug Reaction
AHRQ	Agency for Health Research and Quality
APSF	Australian Patient Safety Foundation
CDSS	Clinical Decision Support System
CHA	Canadian Health Association
CPOE	Computerised Physician Order Entry
GHS	Ghana Health Service
HMPS	Harvard Medical Practice Study
ICPS	International Patient Safety Classification
IHI	Institute for Healthcare Improvement
IOM	Institute of Medicine
ISMP	Institute for Safe Medication Practices
JCAHO	Joint Commission on Accreditation of Healthcare Organisations
MAE	Medication Administration Error
MOH	Ministry of Health
NCC MERP	National Coordinating Council for Medication Error Reporting and Prevention
NPSA	National Patient Safety Agency
QAB	Quality Alliance Board
QAHCS	Quality in Australian Health care study
UK	United Kingdom
US	United States of America
WHA	World Health Assembly
WHO	World Health Organisation

List of Publications

- **Acheampong, F**., Anto, B.P, Boima, V., Koranteng, I., Corquaye, S. (2014). Medication safety activities of hospital pharmacists in Ghana; experiences and expectations of doctors and nurses. *International Journal of Pharmacy and Pharmaceutical Sciences*. 6(10): 525-529. ISSN: 0975-1491

- **Acheampong, F**., Anto, B. P. & Koffuor, G. A. (2014). Medication safety strategies in hospitals - A systematic review. *Int J Risk Saf Med*, 26(3): 117-131. PMID: 25214157

- **Acheampong, F**., Tetteh, A. R., Anto, B. P. (2015) Medication Administration Errors in an adult Emergency Department of a Tertiary Healthcare Facility in Ghana. *Journal of Patient Safety*. March 23, 2015

- **Acheampong, F**., Bruce, E., Anto, B.P. (2015) Medication Safety activities of hospital pharmacists in Ghana; challenges and perceived impact on patient care. *Int J Risk Saf Med* . 27(1):1-10. doi: 10.3233/JRS-150638.PMID:25766062

- **Acheampong, F**., Anto, B. P. (2015) Perceived barriers to pharmacist engagement in adverse drug event prevention activities in Ghana using semi-structured interview. *BMC Health Services Research*. 15: 361. DOI: 10.1186/s12913-015-1031-9

Chapter 1

1 General Introduction

1.1 Background

Many reports have suggested that the success in the use of medicines has unfortunately paralleled the harm caused to its benefactors (Brennan et al., 1991, Leape et al., 1991, Smith, 2004, Donaldson and Fletcher, 2006). This has largely been attributed to the expansion in the medicines available and the complexity in modernisation of medication use in hospitals. (Vincent, 2010). Florence Nightingale had noted that,

> *"It may seem a strange principle to enunciate as the very first requirement in a hospital that it should do the sick no harm"* (Ilan and Fowler, 2005).

In 1999, a report entitled *To Err is Human* was published, providing detailed information about medication error and its consequences. This report has been useful in creating a lot of awareness and has generated a lot of interest in medication error research (Kohn et al., 2000a). This is evident in a Medline search conducted between 1960 to 2000 by Stelfox et al. (2006). The researchers found a sharp rise in the number of publications after the release of the report (Figure 1.1).

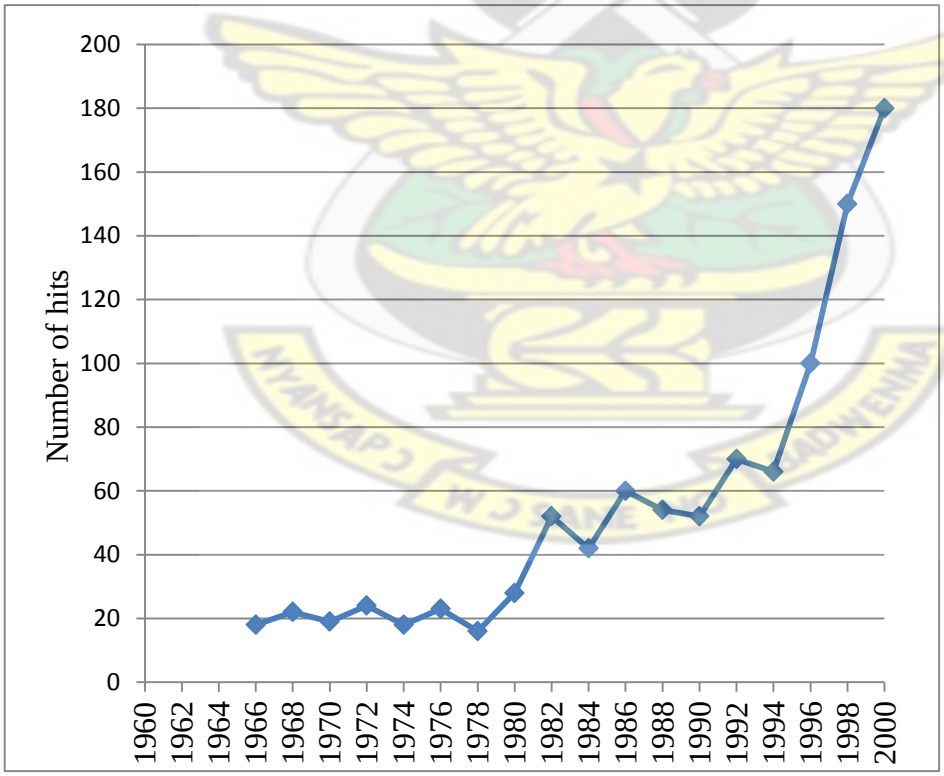


Figure 1.1: Hits obtained using the search term "medication errors" on the Medline database for the years 1996–2000. Only those articles for which "medication errors" was the focus were included; all subheadings were also included (Dean, 2002)].

Medicines form a major part of healthcare. Many studies on have highlighted medication errors as a major cause of adverse events suffered by many patients across the world (Bates et al., 1995a, Leape et al., 1995). These errors have occurred to patients of all ages and in all hospital settings.

In USA, the Harvard Medical Practice study found that many hospital patients were disabled by one form of medical treatment or another and 19% were medication related (Leape et al., 1991). In a much later review by the Australian Council for Safety and Quality in Health Care (2002), it was established that a lot of patients encountered harm on admission in hospitals and medication errors frequently occurred. The incidence of adverse events suffered by patients in UK hospitals has been estimated to be greater than 10% of all admissions and this rate threatens to increase. In 2000, the UK Audit Commission further emphasised the harm caused to hospitalised patients by medication errors (Audit Commission, 2001). Patient harm associated with hospitalization has also been reported in other developed and developing countries including Canada (Sikdar et al., 2010), Germany (Hassan et al., 2010a, Hassan et al., 2010b), Sweden (Hallgren et al., 2003), India (Bhatt, 1999), Jordan (Nazer et al., 2012), Saudi Arabia (Aljadhey et al., 2013), Brazil (Silva et al., 2011) and Ethiopia (Agalu et al., 2012).

As much as 5-10% of hospital admissions are drug related (Zed, 2005). Researchers have also estimated that more than 7000 patients die annually from medication errors in hospitals around the world (Kohn et al., 2000a). Adverse Drug Events ranged from 5.1 to 87.5 per 1000 patient-days of which medication error rates range from 8.1 to 2344 per 1000 patients (Wilmer et al., 2010). An analysis of nearly 300,000 medication prescriptions written during one year in a teaching hospital resulted in an overall error rate of 3.13 errors per 1,000 prescriptions, with the rate of significant errors to be 1.81 per 1000 prescriptions (Lesar et al., 1997a). Though most of these errors may not always result in death, they increase hospital cost (Kohn et al., 2000a). According to the Institute of Medicine report preventable errors are costing the USA, for example, about $2 billion per year (Kohn et al., 2000b). Healthcare systems and practices can contribute to the safe use of medicines.

1.2 Healthcare Systems

Healthcare describes the diagnosis, treatment and prevention of disease, illness, injury and other physical and mental disorders in humans. It is delivered by various professionals in various fields who work in a collaborative manner. Beneficiaries of healthcare access these services differently across countries, and settings. The criteria for access are largely influenced by social, economic conditions and health policies. Healthcare systems are organizations established to meet the health needs of a population. According to the World Health Organization (WHO), to have a responsive health care system would require a robust financial mechanism, well trained and equipped personnel, reliable information and policies, and adequate facilities, equipment and medicines backed by appropriate technologies (WHO, 2010). The health workforce is essential and is harnessed to meet the health needs of the people. In developing countries, healthcare systems are plagued with inadequate resources and hence, they are frequently unable to provide the needed care expected by the health world body.

1.2.1 Healthcare in Ghana

In Ghana, the healthcare system is organised under four main categories of delivery systems: public, private-for-profit, private-not-for-profit and traditional systems. The healthcare delivery is under both the Ministry of Health (MOH) and the Ghana Health Service (GHS) with the MOH providing an overarching role. The MOH is mainly responsible for policy formulation, the monitoring and evaluation of health service delivery throughout the country, resource allocation for health services and the regulation of health services delivery and also develops the framework for the regulations of food, drugs and health service delivery. The GHS is the service provision arm of the health care system in the country, and works to implement national health care policies, provide health care services and manage resources for health care delivery. In addition to the GHS health institutions, there are three teaching hospitals, Christian health facilities, and many other private health clinics. Healthcare in Ghana is financed via insurance schemes and pay-for-access basis.

1.3 Patient Safety

Safety is a global concept that encompasses efficiency, security of care, reactivity of caregivers, and satisfaction of patients and relatives (Vincent, 2006). The safety of patients occupies an increasingly important place among the quality objectives of health systems and it is thus seen as a quality indicator for healthcare systems. Safety is defined as freedom from accidental injury and error as failure of a planned action to be completed as intended or use of a wrong plan to achieve a goal (Kohn et al., 2000b). Developing cultural changes alongside structural reform are useful for ensuring safety (Smits et al., 2012). Safety culture is thus termed as a part of organisational culture and it is commonly defined as 'the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety management (Nieva and Sorra, 2003).

Errors can occur at any stages of patient management, including diagnosis, treatment, and prevention. Two types of execution errors exist: errors of commission (unintentionally doing the wrong thing) and errors of omission (unintentionally not doing the right thing). Patient safety therefore represent key parts of the quality assurance processes in health care settings (Jonsson and Øvretveit, 2008).

1.3.1 Evolution of Patient Safety Research

Up until the beginning of the 21st century, very little research attention was given to the subject of patient safety as compared with safety in aviation and automotive industries (Ilan and Fowler, 2005). The effort and emphasis to ensure flawless performance was not as exciting as progress. Medical errors were not acknowledged to patients and practitioners seldom accepted them as issues to even consider. The emergence of patient safety, as a distinctive set of ideas, was the result of broader movement to improve the quality of care. Other factors that have supported the growth of interest in the subject include high profile cases, lessons from psychology, human factors and high risk industries, litigation and pressure from patients, the public and governments (Vincent, 2010). Many researchers have now given credence to the landmark report on medical errors that was published in the late 1990s by the Institute of Medicine (Leape, 2008). Works on patient safety have improved significantly since then. Patient safety has become a focus of clinical care and research in

recent years. In a review done 5 years after the IOM's report, the author concluded that the report had galvanized the public and health professionals to generate the changes in culture, systems, training, and technology to improve safety (Wachter, 2004).

1.3.2 Patient Safety Terminologies

Patient safety is defined as the avoidance, prevention and amelioration of adverse outcomes or injuries stemming from the process of healthcare (Vincent, 2006). Safety is known to emerge from the interaction of the components of a system and it is more than the avoidance of injuries. Patient safety is thus related strongly to quality of care though they are not synonymous. Though preventing errors form part of patient safety efforts, not all errors lead to patient harm. In effect, it is possible to think about injury reduction without even mentioning the term error. Also, while sophisticated models of the causes of injury can be built, problems can sometimes be circumvented simply by intervening at a critical point in the causal chain (Vincent, 2010). There are various terminologies that relate to the subject of patient safety. The following are the definitions of patient safety key concepts [Adapted from International Patient Safety Classification (ICPS) (Runciman et al., 2009)]:

Safety: the reduction of risk of unnecessary harm to an acceptable minimum.

Patient safety incident: an event or circumstance which could have resulted, or did result, in unnecessary harm to a patient.

Risk: the probability that an incident will occur.

Near miss: an incident which did not reach the patient.

Harm: impairment of structure or function of the body and/or any deleterious effect arising there from. Harm includes disease, injury, suffering, disability and death.

Contributing factor: a circumstance, action or influence which is thought to have played a part in the origin or development of an incident or to increase the risk of an incident.

Side effect: a known effect, other than that primarily intended, related to the

pharmacological properties of a medication.

Mitigating factor: an action or circumstance that prevents or moderates the progression of an incident towards harming a patient.

Ameliorating action: an action taken or circumstances altered to make better or compensate any harm after an incident.

System failure: a fault, breakdown or dysfunction within an organization's operational methods, processes or infrastructure.

1.3.3 Adverse Events and Adverse Reactions

In hospitals, one factor that influences morbidity and mortality is a harmful or unpredicted reaction to a drug. An adverse drug event (ADE) is defined as harm or injury caused by or from the use of a drug (Bates et al., 1995a). The harm can either be preventable or not. Figure 1.2 describes the relationships between ADEs, ADRs and medication errors. The event can occur at any stage in treatment; prescription, transcription and administration. An adverse event attributable to error is a "preventable adverse event." Negligent adverse events represent a subset of preventable adverse events that satisfy legal criteria used in determining negligence (i.e., whether the care provided failed to meet the standard of care reasonably expected of an average physician qualified to take care of the patient in question) (Cullen et al., 1995).

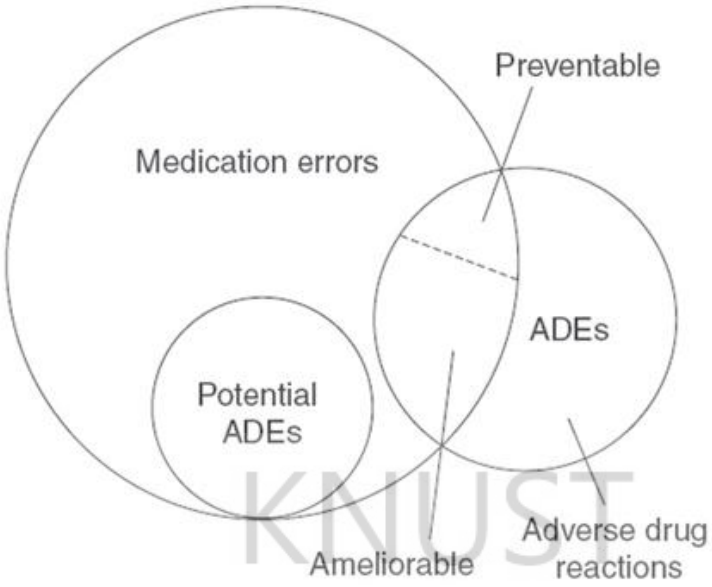


Figure 1.2 : Relationship between ADEs, potential ADEs, and medication errors. (Adapted from Morimoto et al. (2004b) work on error detection and classification)

In the United States, more than half a million patients are injured or die each year in hospitals from ADEs, which may cost up to USD 5.6 million annually per hospital (Classen et al., 2005). In a systematic literature review of ADEs, it showed that one of every 10 hospitalised patients is affected by an adverse event, with a median percentage of 43% being preventable and a 7% lethal rate of events (de Vries et al., 2008). Earlier, Classen and colleagues (1997) had associated the economic burden of ADE with additional cost of hospital stay of USD 2262 per patient and almost twice more riskier of death among patients experiencing ADEs.

In more than 70% of the cases, ADE is related to the dose of the drug administered and not from allergic reactions (Nebeker et al., 2004). In literature, rates of ADEs have been widely studied (Jylha et al., 2011) and they differ in different clinical settings as well as method for their detection (Bates, 2002, Cullen et al., 1997, Jylha et al., 2011, Field et al., 2004). Studies have reported adult inpatients incidence of 6.5% (Bates et al., 1995b), adult outpatients incidence of 27.4% (Gandhi et al., 2003), and paediatric inpatient incidence of 2.3% (Kaushal et al., 2001). Other studies found that in nursing homes, ADEs were at the rate of 1.89 per 100 resident-months, (Gurwitz et al., 2000) while the incidence of ADEs among the aged was 14.4 per 100 older adults (Lund et al., 2010). In a systematic review of ADEs in ICU, rates

varied from 5.1 to 87.5 per 1000 patient-days (Wilmer et al., 2010). The Institute of Safe Medication Practices (ISMP, 2011) has provided the severity of ADEs as follows:

- Category 1: circumstances or processes that have the potential to cause an adverse drug event.
- Category 2: an event occurred but the patient was not harmed.
- Category 3: an event occurred that resulted in the need for increased patient assessments but no change in vital signs and no patient harm.
- Category 4: an event occurred that resulted in the need for treatment and/or intervention and caused temporary patient harm.
- Category 5: an event occurred that resulted in initial or prolonged hospitalisation, affected patient participation in an investigational drug study, and/or caused temporary patient harm.
- Category 6: an event occurred that resulted in permanent patient harm or a near death event, such as anaphylaxis.
- Category 7: an event occurred that resulted in patient death.

ADEs include adverse drug reactions (ADRs) and preventable adverse drug events, which are adverse drug events associated with a medication error. ADR has been defined by the WHO since 1970s as

"a response to a drug that is noxious and unintended and occurs at doses normally used in man for the prophylaxis, diagnosis or therapy of disease, or for modification of physiological function" (WHO, 1972).

1.3.3.1 What is an Error?

An error may be referred literally as a wrongdoing and words such as 'misgivings' have been used to describe it. One may also have acted contrary to the norm or the expected results. A historical grounding may provide a much insight into the terminology. In 1962, Francis Bacon proposed that the human mind assumes far more order and regularity in the world than

it should- perhaps the origin of subsequent theories which has strongly suggested that memory is biased towards over-generalization (Armitage, 2009). This perhaps explain the fact that things that result in accidents have a component of human factor and that human memory and other thought processes can be implicated. Actions and omissions by people are the easy and immediate blame of errors. However, other factors further back in the causal chain can also play a part in the genesis of these errors. These are usually referred to as 'latent conditions' and they lay the foundations for such errors as they create conditions in which the errors thrive (Reason, 2004). Reason (2004) therefore proposed this definition:

'*An error is the failure of a planned action to be completed as intended-without the intervention of some unforeseeable event; or the use of a wrong plan to achieve an aim'.*

Many research works on human related error including ones caused in the medical fields have their perspective originating from this definition. However, other authors have argued for a more practicable definition and thus state that,

'*An error is that something has been done which*

- *Was not desired by a set of rules or an external observer;*
- *Led the task or system outside acceptable limits;*
- *Was not intended by the actor* (Senders and Moray, 1991).

This definition provides that there must be a set of standards, some kind of failure and the person involved did not intend this and must potentially have been able to act in a different way.

The types of error include slips, lapses and mistakes. The difference between slips and mistakes has also been highlighted as it is more difficult to detect mistakes than slips. The main difference is the fact that when one incorrectly executes a correctly formulated plan, then the resulting error is referred to as a "slip" whilst if an individual formulates an incorrect intention (i.e., planning error; he or she does not establish appropriate task parameters) then the subsequent error is referred to as a "mistake."(Bettcher et al., 2011). In order to identify an action as incorrect (i.e., detection), external behaviour is monitored and is compared to an internal representation of the desired state. Finally, lapses are just simply forgetting something and will lead to errors of action or inaction. The person usually knows about the

issue but acts contrary because of the loss of cognisance of the matter in question. These three types can be summarised and grouped into behaviour involved, underlying psychological processes or factors that contributed to it (Vincent, 2010). Another terminology in research is the term '*violations'* which differ from the above classifications of errors. Violation in contrast to errors is defined as *deliberate deviations from set rules and standards and even safe operating practices* (Reason, 1990c).

1.3.4 Patient Safety Initiatives in Developing Countries

Prior to their study in 2012, Wilson et al. reported that published studies had come mainly from developed countries, with very little or no reports from developing or transitional economies (Wilson et al., 2012, Bates et al., 2009). This is a gap in literature that limits the understanding of the global extent of the problem and, more importantly, in these specific countries. Health systems in developing countries face severe threats and challenges in a context of scarce resources and weak infrastructure. There is the need for more studies on patient safety in these countries to guide the formulation of global health policy agenda in these countries and to adopt the most effective and efficient corrective actions. In response to this, the World Health Assembly passed a resolution WHAA55.18 urging member states to pay close attention and research into patient safety (WHA, 2002). The Wilson et al. (2012) study found that adverse events ranged from 2.5% to 18.4% per country. Of these events, about 30% were associated with death of the patient. The most common type of adverse event was caused by therapeutic error (34.2%), followed by diagnostic error (19.1%) and operative (18.4%). Though the study was done in only 8 countries, conclusions were that many other developing economies will probably share similar rates of harm and may benefit from its safety recommendations.

1.3.5 Global Patient Safety Efforts

The issue of patient safety, medical error and adverse event reporting is becoming a high priority in health care systems across the world. Healthcare is complex and high risk as in aviation where adverse events happen and therefore recognising that it has weak systems that create the conditions for error is vital to attaining target levels of patient safety. After the IOM report in USA, many countries including Australia, New Zealand, the United Kingdom,

Denmark, France, the Netherlands, and Canada have replicated the study and instituted patient safety reforms (Leape, 2008).

1.3.5.1 World Health Organisation

Owing to the various publications and media discussions on patient safety after the IOM report, the 57th World Health Assembly in May 2004 supported the creation of an international alliance to improve patient safety as a global initiative (Pittet and Donaldson, 2005, WHO, 2006). The World Alliance for Patient Safety was launched in October 2004. The Alliance brought together a broad range of partners — ministries of health, safety experts, national agencies on patient safety, health care professional associations and consumers with the main aim of achieving improvements in patient safety worldwide. Though individual patients were the focus, all countries are encouraged to develop systems in which medical error, therapeutic accidents and failures are minimised. The Alliance set out to harmonise all national safety programmes and promote medical safety and recommended that all health systems coming to grips with patient safety must address:

- how to prevent patients being harmed during health care
- ways of quickly detecting patient harm and unsafe care
- strategies to ameliorate the effects of any such harm on patients, their families and health care providers
- ways of ensuring system-wide learning which prevents harm to future patients from similar sources of risk (WHO, 2006).

Learning from errors has been identified as a priority area by the body and further recommends that reporting systems must be matched by the developments in systems of response to what is reported. Multifaceted approaches to learning are needed, incorporating a variety of methods, such as clinical audit, pooled analysis of the findings of incident investigations, and proactive identification of risks (Thomas and Petersen, 2003). This encourages interventions and actions, which prevent recurrence of patient safety problems and reduce risks to patients.

The Alliance hopes to continue to build and maintain strong political will and commitment to comprehensive and sustained action by all members and such commitment is needed over the long term. Engagement of front-line health care workers will also be vital in building a more open safety culture. One very important goal will be the need to balance individual and organisational responsibilities for patient safety, which requires well-designed processes and structures of health care delivery.

1.3.5.2 United Kingdom

In 2000 the UK published a report on patient safety *An Organisation with a Memory* (Donaldson, 2002). The Government then showed their commitment to patient safety by issuing a document *Building A Safer NHS For Patients* (Smith, 2004). The document outlined the various practical strategies in instilling safety measures in healthcare delivery. A major part of the plan was the new mandatory, national reporting scheme for adverse health care events and near misses within the National Health Service (NHS) and the sharing of the learnings across the country. Implementing the plan led to the formation of the National Patient Safety Agency (now defunct) which was to:

- *collect and analyse* information on adverse events from local NHS organisations, staff, and patients and carers;
- *assimilate* other safety-related information from a variety of existing reporting systems and other sources in UK and abroad;
- *learn lessons* and ensure that they are fed back into practice, service organisation and delivery;
- produce *solutions*, where risks are identified, *to prevent harm, specify national goals and establish mechanisms to track progress*.

1.3.5.3 Scotland

The Scottish Patient Safety Programme is a unique national initiative aimed to drive improvements across the whole of health system in Scotland. In 2010, the Scottish

Government published the Healthcare Quality Strategy for NHS Scotland and subsequently formed the Quality Alliance Board (QAB) to support and drive the implementation of the Quality Strategy (NHSScotland, 2013). The programme was directed at promoting patient safety within Scotland. One of the key priorities was the support of clinical governance, which was a system of checks and balances that ensures clinical services are of the highest possible quality.

1.3.5.4 United States of America

After the IOM's report, there has been an overall increased sensitivity to the issue of healthcare safety leading to the formation of many institutions. Regulations in healthcare have been enhanced with the strengthening an independent, not-for-profit organization, *The Joint Commission on the Accreditation of Healthcare Organizations* (JCAHO) (Commission, 1951). This is a nationally recognised accreditation agency for hospitals, managed care entities and other types of health care facilities. JCAHO has an established 'sentinel event' reporting system based on formal root cause analysis.

Under the auspices of the United States Department of Health and Human Services, the *Agency for Healthcare Research and Quality* (AHRQ) was formed to develop a broader understanding of what the patient safety problems were and where they occurred in the delivery of health care. AHRQ-supported research was leading to a rethinking of what does and does not work at the health care systems level (AHRQ, 2010).

In its 25 years in existence, another independent not-for-profit organization based in Cambridge, Massachusetts *The Institute for Healthcare Improvement* (IHI) has partnered with visionaries, leaders, and front-line practitioners around the globe to spark bold, inventive ways to improve the health of individuals and populations (IHI, 2013). It is an organisation hosting both seminars and a collaborative approach to reducing error in health care. IHI connects other countries in the world through establishing chapters of students, faculty and field professionals.

Another body in USA, blazing the tag 'Educating The Healthcare Community and Consumers about Safe Medication Practices' *The Institute for Safe Medication Practices* (ISMP) was dedicated to making safety the highest performing function in its member

organisations. This was to ensure that facilities were as safe as possible for patients and staff. As part of this the Institute produces the ISMP Medication Safety Alert (ISMP, 2013).

1.3.5.5 Australia

Australia was one of the first countries to develop a comprehensive national program of action on patient safety and has been at the forefront of international efforts (Coombes et al., 2011). The Quality in Australian Health Care Study was widely regarded as seminal in its efforts to quantify and characterise patient safety problems on a large scale (Donaldson and Fletcher, 2006). In a study, a review of medical records of over 14 000 admissions in Australia hospitals showed that 16.6% of all admissions resulted in disability or a longer hospital stay for the patient (Wilson et al., 1995).

Specific safety initiatives in Australia have been highly regarded worldwide (Pittet and Donaldson, 2005). This includes long established work on incident reporting through the Australian Patient Safety Foundation (APSF) and the pioneering work of the Australian Council for Safety and Quality in Health Care in areas such as open disclosure (Runciman, 2002). Incident reporting tends to provide ways of ensuring system-wide learning which prevents harm to future patients from similar sources of risk. The APSF primary functions are to provide leadership in the reduction of patient and consumer injury in all health care delivery systems; to follow a systems approach to patient safety improvement, based on collaboration with clinicians and health unit staff; and to provide a flow of funds to support ongoing research into patient safety (APSF, 1988).

1.3.5.6 New Zealand

New Zealand has the Health Quality & Safety Commission, which was established to ensure that all New Zealanders receive the best health and disability care within available resources. Some of its programmes include medication safety, reportable events, reducing perioperative harm, reducing harms from falls etc. The success of each of the programmes is measured over time and achievements are used to motivate further improvements. The work of the

commission is summarised in the New Zealand Triple Aim for quality and safety outcomes (Figure 1.3) which has three broader outcomes:

- improved quality, safety and experience of care
- improved health and equity for all populations
- better value for public health system resources.

Figure 1.3: New Zealand Triple Aim for quality and safety (Taken from *Health Quality & Safety Commission* (Commission, 2012))

1.4 Problem Statement

Adverse drug events especially medication administration error occur more frequently globally in all health systems (Sikdar et al., 2010). The Emergency Department (ED) of Korle Bu teaching hospital may be prone to higher rate of errors as it lacks some important basic medical equipment for efficient diagnosis and management of patients. It is sometimes overcrowded and the working environment may provide an impetus for medication use problems. The ED however plays an important part in health care as it serves as one of the last resort for complex medical emergencies in the country and the sub region. Detecting these challenges may lead to the identification of gaps in the treatment process and the factors contributing to these gaps (Aronson, 2009).

The extent of the problem of medication administration error in hospitals is still not fully understood in health systems across the world (Kelly and Wright, 2012). It is therefore important to find the extent of the problem in a Ghanaian setting to inform policy formulation in preventing future occurrences.

Many studies have concluded that adverse drug events are sometimes provoked by weak systems and since it is known that majority of developing countries are more plagued, the phenomenon of errors will tend to be more than the global average. Consequently, there are very little studies from developing country settings to serve this meaningful comparison. The study will seek to bring to the research community an understanding of the subject of medication safety pertaining to the administration process that they may have overlooked.

Pharmacists working in close collaborations with others have been known to prevent the occurrence of adverse drug events (Weingart et al., 2004). They play a vital role in medication safety activities in highly resourced healthcare settings (Acheampong et al., 2014). There may be some peculiar challenges that relate to the relationships that other healthcare professionals have with pharmacists and these may sometimes affect their medication safety roles.

1.5 Justification of the Study

The effect of Medication administration errors could be fatal or very debilitating. Learning about them enables preventive strategies. The research outcome was to be situated in the

policy direction of the department in the continuous efforts to enhance medication safety in the hospital. Accepted operational recommendations could have application nationwide and might even offer medication safety hints for countries in sub-Saharan Africa. Most medication errors may be trivial, however it's detection is important since system failures that result in minor errors could later lead to serious errors (Franklin et al., 2005). Additionally, identifying the extent of the errors will inform health workers and policy makers of the efforts required in addressing them.

Though most medication administration errors may not result in harm to the patient, the ones that do can be very costly to the patient and the hospital. Besides increased hospital costs, preventable adverse events are also responsible for indirect costs, such as loss of productivity, disability, and personal costs related to care (Bates et al., 1995a). Identifying potential causes could assist in designing measures to prevent future occurrences and thereby contribute to reducing health cost.

Many reports have suggested that the success of medicine has unfortunately paralleled the harm caused to its benefactors (Kohn et al., 2000b, Smith, 2004, Care, 2002, Donaldson and Fletcher, 2006, Leape et al., 1991, Brennan et al., 1991). This has largely been attributed to the expansion in the medicines available, lack of pharmacovigilance systems and the complexity in modernisation of medical practice (Vincent, 2010).

Across the world, patient safety has gained a lot of interest by consumers and governments leading to the formation of national organisations to promote the improvement of patient care. The goal of drug therapy is the achievement of defined therapeutic outcomes that improve a patient's quality of life while minimizing patient risk (Hepler and Strand, 1990). In general, safety is increasingly seen as a quality indicator in health care. Adverse drug events remain a substantial challenge to healthcare systems, with medication related events accounting for a large reported number (Audit Commission, 2001, Pirmohamed et al., 2004). Medication administration errors forms about 61% medication related incidents in all healthcare settings in UK (Thomas and Panchagnula, 2008). It will be thus important to determine the extent of MAEs in an emergency setting in a resource restraint environment.

Institutions have designed and implemented many strategies to enhance the safe use of medicines. Notably among them is the use of technology. The cost associated with the use of such strategies is huge (Berger and Kichak, 2004) and may be prohibitive for developing

countries who still grumble with basic healthcare needs. Consequently, pharmacists have been shown to be an essential resource for identifying and preventing medication errors. Pharmacists are uniquely trained and provide comprehensive inputs in the use of medicines in hospitals and help reduce morbidity and mortality (Kaboli et al., 2006a, Kohn et al., 2000b, Bond and Raehl, 2007b). Their collaborative interactions with other healthcare workers like doctors and nurses will make it an effective safety strategy.

1.6 Aims and Objectives

The aim of the study was to identify adverse drug events, explore the perceived and documented roles of pharmacists and understand the perceptions of doctors and nurses toward pharmacists' role in enhancing the safe use of medicines.

1.6.1 Study Objectives

Objective 1: To determine the frequency, types and contributory factors of adverse drug events (ADEs) with emphasis on Medication Administration Errors.

1.1 Determine the prevalence of medication administration errors.

1.2 Identify the various types and frequencies of the administration errors occurring.

1.3 Determine the clinical severity of medication administration errors in emergency department of Korle-Bu Teaching Hospital.

1.4 Explore the potential contributory factors to medication administration errors.

Objective 2: To explore the perceived and documented roles of pharmacists in addressing ADEs.

2.1 Identify routine medication safety activities of pharmacists in Ghanaian hospitals.

2.2 Assess the perceptions of pharmacists on the impact of their activities in patient care.

2.3 Evaluate the documented clinical interventions of pharmacists after potential ADEs have been detected.

2.4 Assess the challenges and barriers to making clinical interventions.

2.5 Evaluate the sequence involved in the process used by pharmacist in undertaking interventions.

Objective 3: To understand the experiences and expectations of doctors and nurses on pharmacists' role in detecting and preventing ADEs.

3.1 Determine the frequency and reasons for interacting with pharmacists.

3.2 Explore the experiences of doctors and nurses with pharmacists.

3.3 Explore the perceptions, views and attitudes of doctors and nurses toward current pharmacists' medication safety activities.

1. 6.2 Overview of the Thesis

The rest of the thesis is divided into five chapters. Chapter two reviews the literature on adverse drug events with emphasis on medication administration errors. Errors occur during the medication use processes i.e prescribing, dispensing and administration. Medication errors have been reported to occur frequently in hospitals around the world. This chapter presents the extent of medication administration errors in a Ghanaian setting. A systematic review of medication safety strategies is also presented. There are a lot of strategies to ensure the safe use of medicines. Notably among them is the pharmacist. The chapter continue to look at the views of pharmacists on the role they play in addressing potential adverse drug events in hospitals. Moreover, a review of documented clinical interventions of pharmacists after adverse drug events have been detected is presented. This is to understand the how pharmacists ensure medication safety and the challenges they face in performing those activities. For pharmacist to perform these activities, they need to be in collaborative working relationships with other clinical staff, especially doctors and nurses. Chapter three presents the methods employed in all the studies. The results of the study are concisely presented in chapter four. Chapter five discusses the major findings while chapter six present conclusions, recommendations, limitations, applications for the findings of this study, and possible future research.

Chapter 2

2 Literature Review

2.1 Introduction

Injuries due to medication use, referred to as adverse drug events, represent the most frequent cause of injuries due to medical care in hospitals (Leape et al., 1991). Studies have found that 6.5% of adult inpatients, 27.4% of adult outpatients, and 2.3% of paediatric inpatients developed ADEs (Morimoto et al., 2004b). The consequences of ADEs range from relatively minor symptoms such as a rash to death and ADEs also result in important consequences including hospital admission, prolonged hospital stay and additional resource utilization (Bates et al., 1995c). The epidemiology and nature of ADEs and medication errors in hospitals have been described in detail in some developed countries, but almost all the available data come from these nations (Jha et al., 2010). Without such basic data from all parts of the world, the effectiveness of various solutions attested in some Western countries cannot necessarily be extrapolated to local settings worldwide (Morimoto et al., 2004a). Therefore, investigating the epidemiology and nature of ADEs in Ghana is essential for devising local safety strategies. ADEs can occur at any stage in the medication use process, including ordering, transcribing, dispensing, administering and monitoring.

2.2 Medication Use Process

Dating back the ancient days of *papyrus* and the *apothercaries,* drugs have been part of disease diagnosis, prevention and treatment. Drugs continue to be useful in modern day healthcare. The medication use process is complex and consists of different phases; prescribing, transcribing, dispensing, administration and monitoring, and involves many different agents, i.e physicians, pharmacists, nurses and patients. Figure 2.1 provides a diagrammatic representation of the medication use process. The medication use process begins with prescribing. Traditionally, a doctor prescribes, pharmacist or pharmacy technician dispenses and nurses administer. In some setting the prescribing role is being performed together with pharmacists or by pharmacists alone (Tonna et al., 2007, Avery and Pringle, 2005, Galt, 1995, Stewart et al., 2008) and nurses (Latter et al., 2010, Luker et al., 1997, Wilhelmsson et al., 2001). The safe use of medicines is therefore the responsibility of all players in the healthcare team.

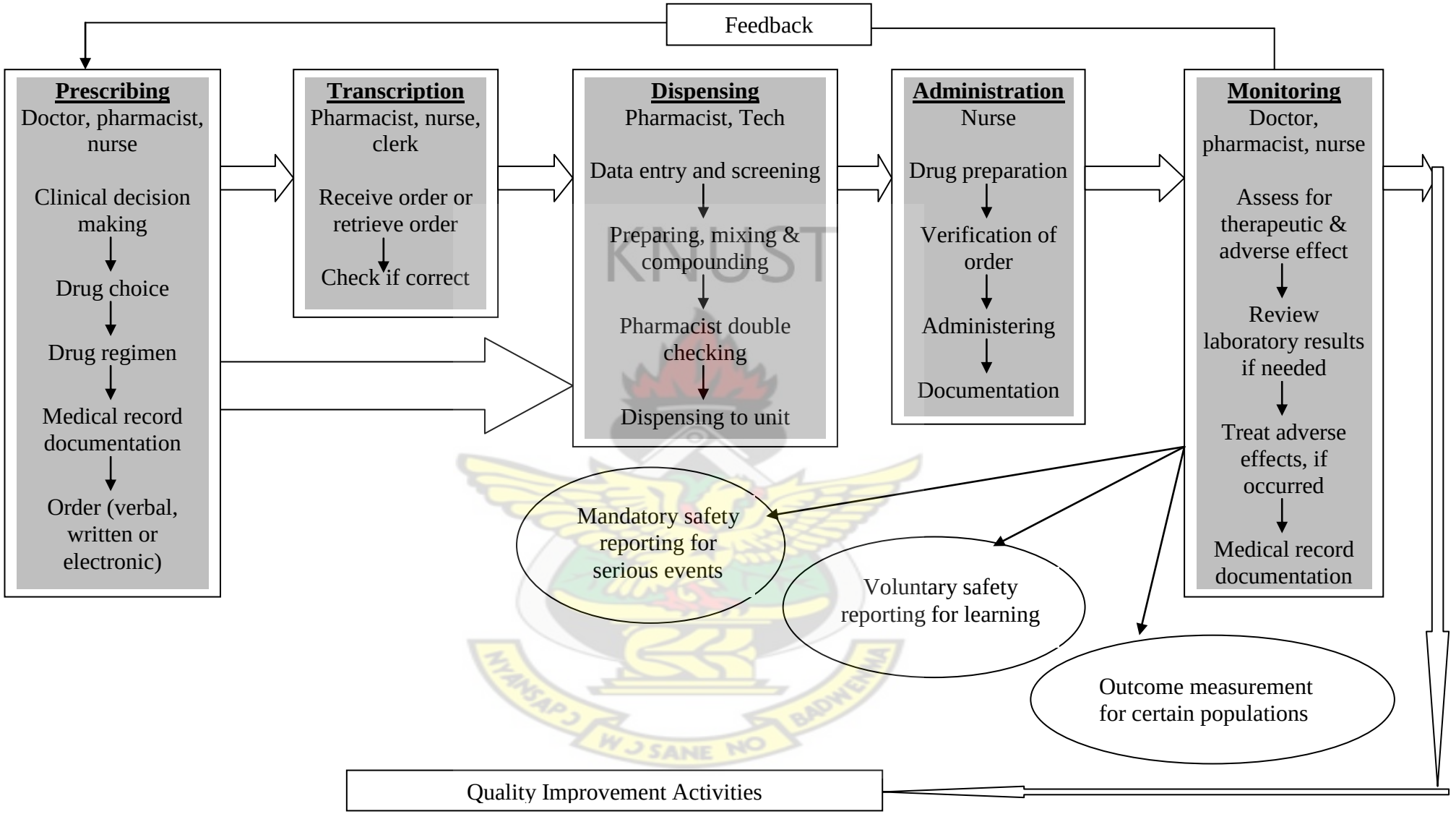


Figure 2.1: Medication use process [Adapted from National Academies Press (Aspden et al., 2006)]

2.3 Medication Errors

2.3.1 Definitions

The definition and categories of medication errors (MEs) vary throughout the literature. The initial definition of ME was "a deviation from physician's medication order as written on the patient's chart" (Allan and Barker, 1990). In effect, this definition excluded the other processes of medication use, which is equally important as prescribing. Later, researchers defined it simply as any error in prescribing, dispensing or administration of medication (Franklin et al., 2005). It may also include compounding and transcribing where relevant. One set of proposition was that an ME only occurred if it resulted in harm to the individual. Others argue that an ME may or may not result in patient harm, but is considered to be preventable. A review of literature by Aronson and Ferner (2005) provided a broader definition to the term as;

'a failure in the treatment process that leads to, or has the potential to lead to, harm to the patient'.

This definition thus excludes 'near misses'. Ferner (2009) had strongly defended their position because the absence of a relationship between the frequency of harm and no-harm incidents is perhaps less a reason for counting only errors that result in harm than a reason for detailed investigation of the likelihood of possible harmful outcomes from errors that themselves cause no harm. Yu et al. (2005) subsequently evaluated several definitions and found the definition of Aronson and Ferner to be the most robust. However, there have been strong debates in support of including 'near misses' to especially aid in designing organisational strategies for error prevention. Although MEs do not lead to harm in many cases, they provide the unique opportunity to identify the need for system changes, which have the potential to prevent harm to patients and also allows for change for safer policies.

The National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) (1998) also provides a more elaborate definition of an ME 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 errors in prescribing, order communication, product

labelling, packaging, nomenclature, compounding, dispensing, distribution, administration, education, monitoring, and use.'

Lisby and colleagues (2012) asserted that the definition provided by the NCC-MERP was complex, awkwardly phrased, and non-exhaustive, as the detailed list included elements seemed to draw attention to what was not included. They therefore used a modified Delphi-process of consensus employing Danish experts and selected a definition considered as being more operational and adequate for clinical practice to be

"An error in the stages of the medication process − ordering, dispensing, and administering and monitoring the effect − causing harm or implying a risk of harming the patient"

The wide variation in methods and definitions means it is virtually impossible to compare different studies. The multiplicity of definitions demonstrates the urgent need for a universal agreement on standardisation of nomenclature to aid in comparison among studies.

2.3.2 Medication Error Rates

The Institute of Medicine's (IOM) (2000b) first Quality Chasm report, *To Err Is Human: Building a Safer Health System*, stated that Medication errors were a significant cause of morbidity and mortality; accounted for one out of 854 inpatient deaths (IOM, 2001). Several studies from various countries have reported that 3.7–16.6% of total hospital admissions were associated with adverse events, a major proportion of which were attributed to medication use (Brennan et al., 1991, Wilson et al., 1995, Baker et al., 2004, Davis et al., 2002). Dean (2002b) also found that medication errors formed a substantial portion of medical errors in hospitals and it was estimated to harm 1-2% of all admitted patients. Error rates in literature differ for different study settings, and different methods of data collection. For example, more events were recorded when multifaceted methods of detection were used (Wilmer et al., 2010). Among hospitalized patients, studies have shown that errors may be occurring as frequently as one per patient per day (Wu et al., 2002, Cowley, 2000). In paediatric intensive care unit studies, reported medication error rates have ranged from 5.723 and 14.6 per 100 orders (Buckley et al., 2007) to as high as 26 per 100 orders (Schneider et al., 1998). Medicine use in specialty areas (e.g., intensive care units, emergency departments, and diagnostic and interventional areas) are associated with increased risk (Wilmer et al., 2010).

In an adult intensive medical unit, MEs recorded was 129.5 per 1000 patient-days (Rothschild et al., 2005).

2.3.3 Medication Error Classification

According to the NCC-MERP (1998), ME is broadly classified as causing harm or no harm. These are further classified into various categories as shown in Table 2.1.

Table 2.1: Classification of medication error repercussions (Adapted from NCC-MERP (1998))

CATEGORY	SUB CATEGORY	DESCRIPTION
NO ERROR	A	Circumstances or events that have the capacity to cause error
ERROR, NO HARM	B	An error occurred but the error did not reach the patient
	C	An error occurred that reached the patient, but did not cause patient harm
	D	An error occurred that reached the patient and required monitoring to confirm that it resulted in no harm to the patient and/or required intervention to preclude harm
ERROR, HARM	E	An error occurred that may have contributed to or resulted in temporary harm to the patient and required intervention
	F	An error occurred that may have contributed to or resulted in temporary harm to the patient and required initial or prolonged hospitalization
	G	An error occurred that may have contributed to or resulted in permanent patient harm
	H	An error occurred that required intervention necessary to sustain life
ERROR, DEATH	I	An error occurred that may have contributed to or resulted in the patient's death

2.3.4 Types of Medication Errors

The broad types of medication errors are prescribing errors, dispensing errors and administration errors. Errors can also occur in the other stages of the process, which is, transcribing and monitoring. Transcription errors occur when transcribing or interpreting a medication order of the physician. In literature, no sub classification of transcription errors can be found: an order is either transcribed correctly or not (Van den Bemt and Egberts, 2007).

Prescribing errors

Prescriptions are the primary means of communicating medication instructions between prescribers and pharmacists or others. Coordinating this communication process could avert some of the effects of the disjoint that ensue. Inappropriate prescribing most often derives from a wrong medical decision, because of lack of knowledge or inadequate training (Lesar et al., 1997a). Errors are more frequently made by junior members of staff and inadequate knowledge or training often underlie inappropriate prescribing and other faults (Velo and Minuz, 2009). In 2000, Dean and colleagues (2000) used a two stage Delphi technique to derive a practitioner led definition of prescribing error. The process yielded a definition as follows:

"*A clinically meaningful prescribing error occurs when, as a result of a prescribing decision or prescription writing process, there is an unintentional significant (1) reduction in the probability of treatment being timely and effective or (2) increase in the risk of harm when compared with generally accepted practice*".

The American Health-Systems Pharmacists (ASHP, 1989) defines PE as:

Incorrect drug selection (based on indications, contraindications, known allergies, existing drug therapy, and other factors), dose, dosage form, quantity, route, concentration, rate of administration, or instructions for use of a drug product ordered or authorized by physician (or other legitimate prescriber); illegible prescriptions or medication orders that lead to errors that reach the patient.

This definition does not acknowledge *near misses* as errors that should be considered. This underestimate error rate and does not encourage development of more preventive strategies.

Errors in the prescribing are common and have been identified as a major cause of adverse drug events (Bates et al., 1995a, Folli et al., 1987, Lesar et al., 1990, Bates et al., 1995c, Leape et al., 1995, Leape et al., 1991, Bates et al., 1993). There has been inconsistency in research into the prescribing error rates. For example, prescribing errors have been said to occur in 0.4–15.4% of prescriptions written in the US (Lesar et al., 1997a) and in 7.4–18.7% of those written in the UK (Fowlie et al., 2000). Another study found PEs occurring in 0.3-16.9% of prescriptions written (Lewis et al., 2009). Moreover, error rates also vary across different hospital settings. In a nephrology ward, clinical pharmacist identified 10.5% error rate (Vessal, 2010) whiles at an emergency department, the error rate was 6.2% (Lesar, 2002).

Few studies from developing countries have been sighted and they showed similar disparities in the error rates. A Pakistan study reported error rate of 22.6% of all inpatients (Shawahna et al., 2011b). In India, a prospective public teaching hospital study (Pote et al., 2007) and a paediatric ward study (Aneja et al., 1992) found error rates of 34% and 37.7% respectively in all cases seen. However higher PE rates of 56% was found in a study done in Saudi Arabia (Al-Jeraisy et al., 2011) and 90% in Sudan (Yousif et al., 2011).

Dispensing errors

In general, a discrepancy between a prescription and the medicine that the pharmacy delivers to the patient or distributes to the ward on the basis of this prescription, including the dispensing of a medicine with inferior pharmaceutical or informational quality, can be termed as a dispensing error (Ashcroft et al., 2005, Van den Bemt and Egberts, 2007). Beso et al. (2005) defined dispensing error as;

"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. Any deviation from professional or regulatory references, or guidelines affecting dispensing procedures, was also considered a dispensing error."

The hospital pharmacy's medication dispensing process is a source of medication errors and potential adverse drug events. Many drugs are dispensed daily from pharmacies. Studies have

reported conflicting rates of pharmacy dispensing errors, ranging from 0.0041% to 3.6% (Bates et al., 1995c, Rolland, 2004). These differences were largely due to differences in study design and settings, methods of detection and error concepts. Some studies relied on self-reporting to detect dispensing errors and likely underestimate the incidence of these errors. Other studies evaluated dispensing errors in settings where pharmacists do not verify orders that have been filled by technicians. In the hospital settings, errors are reported mainly by nurses and sometimes other pharmacy staff, prescribers and patients. A study which was based on 7158 errors reported in 89 hospitals was reported by hospital nurses (45%), hospital pharmacists (17%) or patients (17%), and most commonly involved the wrong drug (23%), wrong strength (23%), wrong directions (10%) or wrong quantity (10%) (Roberts et al., 2002). In a study done in a UK teaching hospital (Beso et al., 2005), one or more dispensing errors were identified at the final check stage in 2.1 % of 4849 dispensed items, and outside of the pharmacy department in 0.02% of 194,584 items. The majority of those identified at the final check stage involved slips in picking products, or mistakes in making assumptions about the products concerned. In a Brazilian paediatric hospital, out of the 300 identified errors, 262 (87.3 %) were content errors and the rate of errors in the labelling and documentation categories was 33 (11%) and 5 (1.7%), respectively (Costa et al., 2008).

2.3.5 Medication Administration Errors

Medication administration error (MAE) is generally defined as any deviation from the physician's medication order as written on the patient's chart (Allan and Barker, 1990). An author provided a modification of this to include any deviation from standard hospital policy or the manufacturer's instructions (Taxis and Barber, 2003a).

The medication administration process is very important during the management of patients in hospitals. Like the other stages in the medication use process, it represents a source of potential risks. The characteristics of this process (complexity of the procedures, multiplicity of professionals and services involved, rapid introduction of new drugs, diagnostic and therapeutic technologies, etc.) frequently provoke errors that hamper patient care quality and generate an increase in healthcare costs (Dean, 1999, Greengold et al., 2003). The quality of this process is guided by work conditions, supervision, existence of continuing education programmes and professional qualification. As the last stage of patient receiving medications,

errors could easily go undetected. Well-designed preventive strategies including bar coding can be helpful in addressing this challenge.

2.3.5.1 Incidence of MAEs in Hospitals

MAEs occur more frequently in hospitals. In a prospective study (Agalu et al., 2012) done in the ICU of a hospital in Ethiopia, prevalence of medication administration errors was 621 (51.8%). Common administration errors were attributed to wrong timing (30.3%), omission due to unavailability (29.0%) and missed doses (18.3%) among others and errors associated with antibiotics took the highest in medication administration errors (36.7%). Another study (Rodriguez-Gonzalez et al., 2012) conducted within two clinical units of the Gastroenterology Department in a 1537-bed tertiary teaching hospital, 509 errors were recorded representing 22.0% of which 68 (13.4%) were in preparation and 441 (86.6%) in administration. In this study, the most frequent errors were use of wrong administration techniques (13.9%), wrong reconstitution/dilution (1.7%), omission (1.4%), and wrong infusion speed (1.2%). Haw and colleagues (2007) detected a 25.9% MAEs using a direct observation in a two elderly long-stay wards of an independent UK psychiatric hospital.

Medication administration errors (MAEs) were the most common (61%) medication related incidents in all care settings in the UK for 2006 and 2007 (Thomas and Panchagnula, 2008). This is expected to be higher in specialised units like the emergency department where studies have shown that the urgency and busy work schedules create an error prone environment compared to other areas in the hospital (Burstin, 2002, Peth, 2003, Cobaugh and Schneider, 2005). The identification and documentation of medication errors for the purposes of learning is the norm in most hospitals in the developed world. Nevertheless lessons learned from the analysis of these errors may be somewhat difficult to apply in a less developed country as a result of peculiar differences in healthcare systems. This study was undertaken in a developing country with the aim of identifying the types and potential causes of medication administration errors in a presumably less developed healthcare system. This is imperative since medicines administration may be plagued with peculiar systemic failures that underpin error causations as described by Reason (1995a).

2.3.5.2 Clinical Significance of MEs

MEs have been classified in terms of their clinical significance as "potentially serious, not serious" (Dean et al., 2002b), "minor, moderate, major" (Shulman et al., 2005) or using a scale of 0 to 10 where 0 represented a case with no clinical effect and 10 a case that would result in death (Dean and Barber, 1999).

Authors (Lesar et al., 1990) also provide that errors are termed in 'potential' severity forms since errors are usually prevented from persisting with an ever increasing probability of causing harm. The classification is as follows:

A. Potentially Fatal or Severe E.g. The dose received for a medication with a low therapeutic index was greater than 10 times the normal dose.

B. Potentially Serious E.g. The dose ordered for a medication with a low therapeutic index was 4 to 10 times the normal dose.

C. Potentially Significant E.g. The dose ordered of a medication with a low therapeutic index was 1.5 to 4 times the normal dose, with potential toxic reactions because of the high dose.

D. Problem Orders E.g. Duplicate therapy was prescribed without potential for increased adverse effects.

2.3.5.3 Emergency Department (ED) and MAEs

ED visits grow every year across the world and many visits are as a result of adverse drug events (Sikdar et al., 2010). The total number of attendances in UK and other countries increased from 14.6 million in 2002/2003 to 19.6 million in 2008/2009 (Bankart et al., 2011). The environment in the ED may be more conducive to MAEs than other areas of the hospital (Burstin, 2002, Brown, 2005). The high throughput, rapid turnover of patients and junior prescribers staffed at the ED could be thought to lead credence to a possible high incidence of medication errors. In addition, the emphasis on efficient rapid care, frequent "Barriers to patient safety" such as fatigue, stress, anxiety, fear of blame, distractions, noise, and location of critical supplies can have an effect on the risk for errors that is present within the system (Goldmann and Kaushal, 2002). Medication errors commonly occur in the emergency department, affecting up to 60% of patients (Patanwala et al., 2010). In a National US

surveillance of emergency department over a 2-year study period, 21298 adverse drug event cases were reported. Of these cases, 3487 individuals required hospitalization (annual estimate, 117 318 [16.7%]; 95%CI, 13.1%-20.3%). Adverse drug events accounted for 2.5% of estimated emergency department visits for all unintentional injuries and 6.7% of those leading to hospitalization. Drugs for which regular outpatient monitoring is used to prevent acute toxicity accounted for 41.5% of estimated hospitalizations (Budnitz et al., 2006).

2.3.5.4 Nurses and MAE

Nurses may make errors like other health professionals but nursing vigilance is extremely important in preventing errors from reaching the final patient. This will require that nursing workspaces and processes be organized in a way so that work is more efficient, the space is less conducive to the commission of errors, and the space allows nurses to detect and remedy errors when they happen. In a perception study of health care professionals (Wolf et al., 2000), drug administration was the phase in which respondents believed the most errors occurred. In addition, nurses were guiltier, worried, or embarrassed than physicians or pharmacists about making errors. Nurses have personally reported factors such as lack of medication knowledge, failure to double check patient identification, failure to check for new medication orders, incorrect reading of labels and calculation problems as the contributing factors for many of the errors they commit (Armutlu et al., 2008, Greengold et al., 2003). Others have attributed in a study 'Personal neglect', 'heavy workload' and 'new staff' as the three main factors whiles 'Need to solve other problems while administering drugs', 'advanced drug preparation without rechecking,' and 'new graduate' were also blamed for errors caused by the nurses (Tang et al., 2007).

In a study, 61 medical-surgical nurses surveyed agreed that implementation of technological systems such as computer-prescriber order entry and barcode medication administration has resulted in a decrease in medication errors (Ulanimo et al., 2007).

2.3.5.5 Potential Causes of MAEs

There are many causes of MAEs that researchers have identified (Dean et al., 2002a, Jylha et al., 2011, Taxis and Barber, 2003b, Rex et al., 2000, Reason, 1995b, Harrison et al., 1999, Donahue and Needleman, 1998). These factors have been classified as resulting from two approaches: personal and systemic. Each of these has its model of error causation and each model gives rise to quite different philosophies of error management. Understanding these differences has important practical implications for coping with the ever-present risk of mishaps in clinical practice.

Personal approach

Medical personnel are human beings and they make mistakes. Until recently, there was a longstanding and widespread tradition that focused on the individual practitioner as the only cause of an error. Healthcare staff accused themselves as engaging in unsafe acts and procedural violations that have resulted in errors (Reason, 2000a). The approach views these unsafe acts as arising primarily from aberrant mental processes such as forgetfulness, inattention, poor motivation, carelessness, negligence, and recklessness. Other person–dependant factor has also been identified as lack of knowledge (Ross et al., 2012). In effect, the associated counter measures were directed mainly at reducing unwanted variability in human behaviour. These methods included poster campaigns that appealed to people's sense of fear, writing another procedure, disciplinary measures, threat of litigation, retraining, naming, blaming, and shaming. Some proponents of this approach treat errors as moral issues and suggested that errors happen with bad people. Reason (2000b), in his *human error* theory, has argued that, it is easier for people to blame individuals when errors occur. The theory proposed that everything that happens can be traced to either an individual or groups of people. He agreed that this could be true for some cases but could not be generalised, especially in the field of medicine. A difficulty with this approach will be that, contributory factors will be overlooked though they can cause other errors with different people. Lessons learnt from the aviation industry attributes quality lapses to system failures. Effective risk management depends crucially on establishing a reporting culture and without a detailed analysis of mishaps, incidents, near misses, we have no way of uncovering recurrent error traps or of knowing where the “edge” is until we fall over it (Reason, 2004).

System approach

Unlike the personal approach, medical errors arise from the concatenation of several contributing factors originating at many levels of the system. These, in combination with local triggers, open a window of opportunity in which the hazards are allowed to pass unchecked through successive weaknesses in what the military and the nuclear industry have termed defences in depth (that is, a defensive system that involves successive barriers, each designed to support the others). Because of the many layers of protection, such accidents are rare events. They require the simultaneous alignment of gaps or absences within what are usually diverse and redundant defences. These aspects are encapsulated in the Swiss cheese model of organisational accidents shown in Figure 2.2.

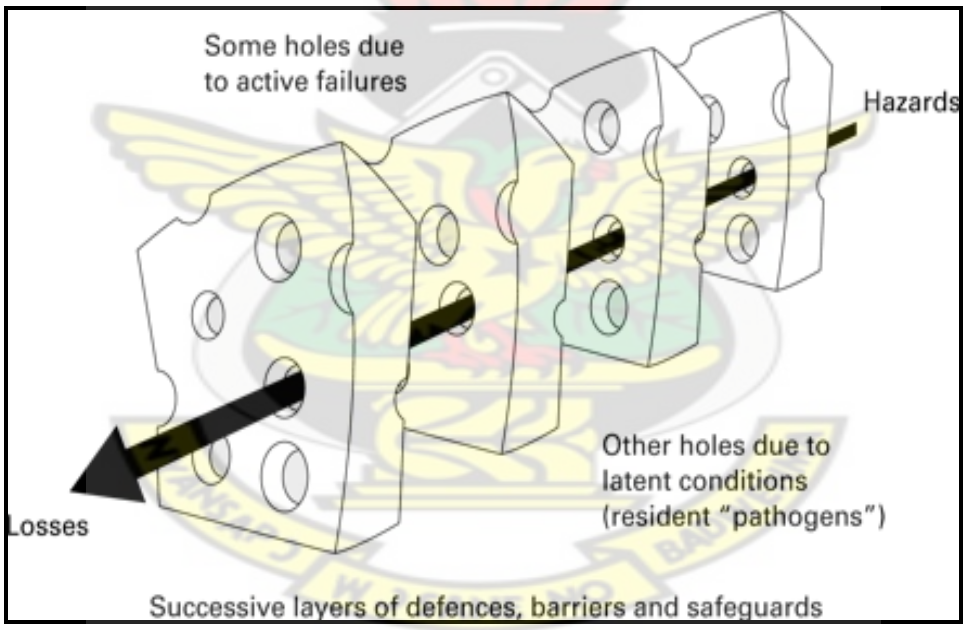


Figure 2.2: Swiss cheese model adapted from James Reason's 'Human error, models and management'(Reason, 1990b).

The model stipulates that in an ideal world, the defensive layers would be intact. However, in reality, they are more like Swiss cheese (full of holes) though they constantly change their

orientation. These gaps, weaknesses, and failures (or the complete absence of necessary safeguards) occur for two reasons:

1. Active failures—these are unsafe acts (errors or procedural violations) on the part of those in direct contact with the system that create weaknesses among the protective layers.

2. Latent conditions—these are defensive gaps, weaknesses, or absences that are unwittingly created as the result of earlier decisions made. These lie dormant in the system until other factors trigger their change into error provoking conditions.

These two set of factors are usually required to be present when adverse events occur (Figure 2.3). The understanding of these processes will make proactive measures more useful than reactive safety approaches as it is more difficult to change human beings than the environment in which they work in. The human factor theory thus proposes for comprehensive risk management strategy for the healthcare industry.

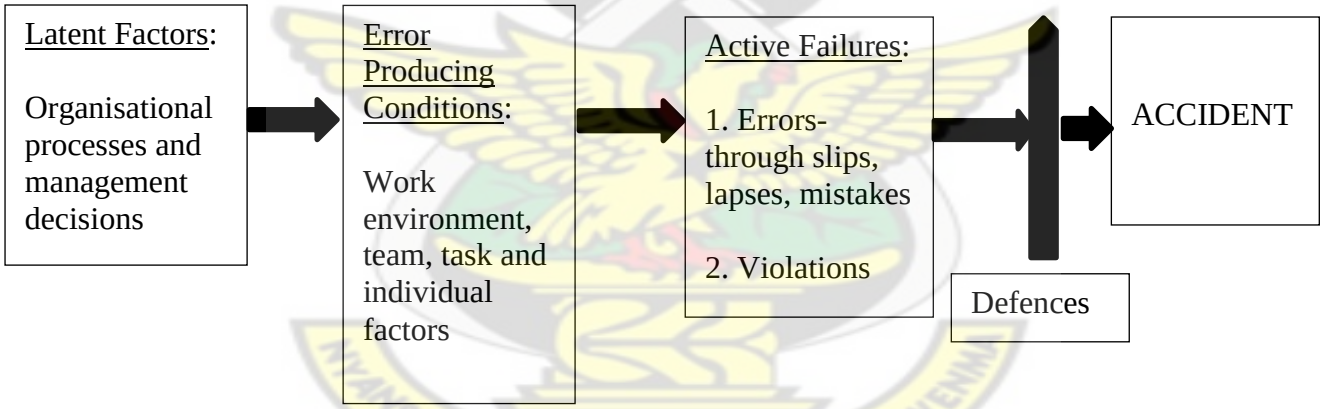


Figure 2.3: Modified version of Reason's model of accident causation (Dean et al., 2002a)

2.3.6 Opportunities for Medication Administration Errors in Tertiary Care Setting in Ghana

Medication administration error occurs frequently (Rodriguez-Gonzalez et al., 2012) and it is important to know the extent of the problem. The Emergency Department (ED) of the study

hospital may be prone to higher rate of errors as it devoid of state-of-the-art medical equipment. It is sometimes overcrowded and the working environment may provide an impetus for medication use problems. The ED however plays an important part in health of the populace as it serves as one of the last resort for complex medical emergencies. Detecting these challenges could lead to the reveal of failures in the treatment process and subsequent view of the factors contributing to these errors.

The extent of the problem of medication administration error in hospitals is still being studied as literature reviews their existence across other settings in the world.

Many studies have concluded that medication errors are sometimes provoked by weak systems (Reason, 1990a). Majority of developing countries are more plagued with weak systems, the phenomenon of errors could be more than the world's average (Wilson et al., 2012).

2.3.7 A case of Medication Administration Error in Ghana

On the 11th February 2014 there was a front page story of Daily Graphic of 2 Children who lost limbs due to wrong use of intravenous infusion (see Figure 2.4) (Zakaria, 2014). It was reported that the error resulted from medication administration error involving the wrong technique used in administering intravenous medication. The victims, both males, were a 10-month-old baby, whose left arm has been amputated, and two-and-half-year-old, who has had his right arm amputated. The incidents occurred separately at a private clinic in Tamale and at the Bimbilla Hospital in the Nanumba South District in the Northern Region of Ghana Northern Region respectively.

The report stated that the victims had been sent to the health facilities on account of diarrhea and severe vomiting respectively and were to receive rehydration and medication via parenteral route. The technique used by nursing staff in setting up parenteral routes caused gangrene on their limbs leading to amputations. Errors with the use of wrong administration techniques have been reported to occur frequently in other studies (Rodriguez-Gonzalez et al., 2012, van den Bemt et al., 2009). Intravenous route of administration predisposes patients to harm and would require specific safety strategies.

Figure 2.4: Two children with amputated limbs due to MAE (Taken from Daily Graphic online)

2.4 Medication Safety Strategies in Hospitals- Systematic Review of Literature

The extent to which medication-related incidents occur is a topic of increasing concern to patients, clinicians and policy makers. Increasingly, many researchers continue to explore new and effective ways to improve medication safety studies. Authors of some of the largest adverse event studies have advocated for the implementation of selected evidence-based studies especially in developing countries like Ghana (Brennan et al., 2005). This will be especially important because of the resource-constraint nature of the healthcare systems. In the past decade, following the IOM's report, research has provided evidence for many interventions for reducing the occurrence of medication errors and adverse drug events (Bates, 1996, Bates et al., 1995b). Some organisations have recommended very simple steps to reduce errors but unfortunately, though of common sense, they have not been subjected to formal studies (ISMP, 2013). More sophisticated and substantially more expensive solutions have been proposed.

2.4.1 Search Strategy

A search was conducted of PubMed, CINAHL, EMBASE, Journals via Ovid, International Pharmaceutical Abstract, Science Direct, Web of Science, and Science Citation Index Expanded for relevant English language articles. The literature search was done in April 2013 and all articles written up to that date were eligible for selection. A combination of search terms were used by employing Boolean operators 'OR' and 'AND' where necessary. The search terms were 'medication', 'drug', 'medicine' 'use', 'prevention', ' intervention', 'errors', 'adverse drug events', near miss', 'safety', ' strategies', 'reduction' and 'hospitals'.

2.4.1.1 Study Selection

During the search, a first reviewer screened all the titles and available abstracts. Only full research papers performed on humans were eligible for inclusion. Studies undertaken outside the hospital setting were excluded. Details of articles selection flow-chart is shown in Figure 2.5. Conference abstracts, commentaries, letters, editorials, case- reports, systematic review articles and studies that did not provide safety strategies were excluded. Full papers of selected studies were retrieved and further examined, including their reference lists. Articles were selected if they reported on the following:

- systems to promote improved prescription writing and prescriber decision-making;
- systems used to promote accurate distribution and dispensing of medicines;
- systems used in safe administration of medicines;
- systems to improve management of medicines;
- clinical pharmacy services;
- systems to improve information transfer about medicines
- approaches to reduce and prevent medication errors
- systems to promote strategies for adverse drug reactions in hospitals.

The selected articles were then independently reviewed by a second person to determine whether they met the inclusion criteria. Any differences were resolved by discussion to obtain consensus.

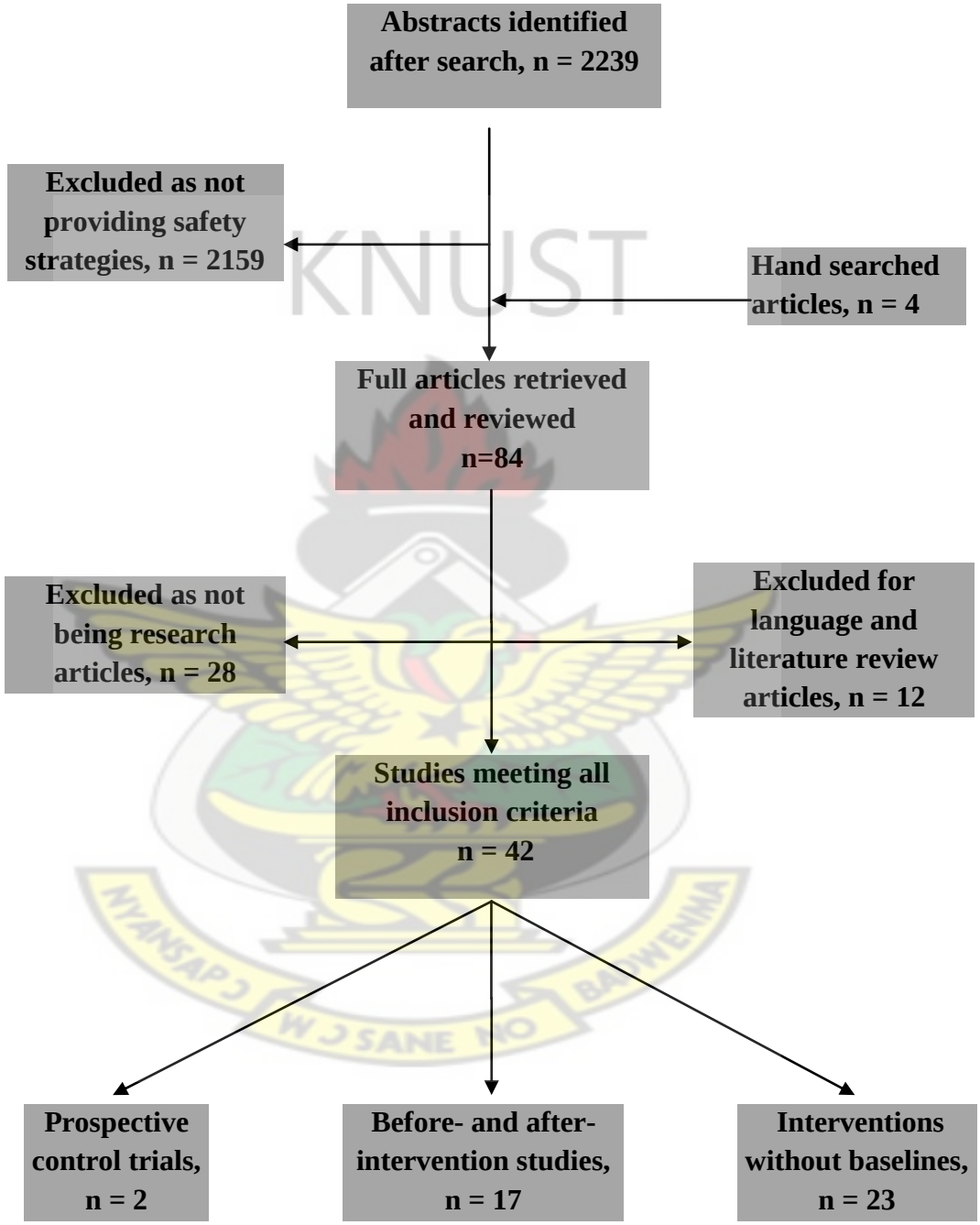


Figure 2.5: Flow chart of article selection

2.4.1.2 Data Extraction and Assessment

The first reviewer using a standard form that included the country of study, year of publication, setting, study design, sample size, intervention type, and outcomes obtained for the intervention strategies extracted data. The second reviewer then verified the data and discrepancies were clarified and corrections made appropriately. Two reviewers independently assessed the quality of each study and any disagreements were resolved by consensus.

2.4.2 Results of Review

The initial search identified 2239 papers. Another four papers (Cunningham, 2012, Fernández-Llamazares et al., 2012, Patanwala et al., 2012, Kazandjian et al., 2009) were added from hand-searching references and medication- safety- specific journals, leading to a total of 2243 papers. Abstracts (n = 84) were selected for further examination and 56 full papers were identified for additional screening. Of these, 42 papers met all the inclusion criteria and were therefore considered relevant for data extraction. There was a 100% agreement between the two reviewers on the inclusion of these studies.

2.4.2.1 Study Characteristics

The characteristics of the 42 included studies are outlined in Table 2.2. The studies identified 5 main intervention strategies employed in hospitals: computerized physician order entry with or without clinical decision support systems, pharmacists' role, automation, computer assisted including bar code technology, education and training and system design. The study sites ranged from 10-bed unit to 35 hospital settings. Studies were conducted in both adult and paediatric units.

Of the 42 included studies, 25 were from the United States. Most of them (n=17) were prospective pre- and post- intervention studies and 8 were retrospective reviews on intervention outcome studies. The pre- and post- intervention studies used neither equivalent control groups nor equivalent pre- and post- intervention groups. However, most of these studies calculated their statistical significance differences.

Table 2.2: Characteristics of selected 42 studies

Study	Country & year	Study setting	Study design, Study period, Sample size	Type of Intervention	Outcome of intervention
Computerized physician order entry (CPOE)					
Van Doormaal et al (2010)	Netherlands 2010	2 general internal medicine + 1 gastroenterology/ rheumatology ward	Data extraction of hospital information system, medical charts and administration charts review. Compare intervention with manual pharmacist review	Computerized physician order entry with Clinical Decision System Support(CDSS)	Prevention of medication-related patient harm
Wetterneck et al (2011)	USA 2011	2 intensive care units of 400 bed rural community tertiary care hospital	Prospective pre- and post-intervention observational trial. No control group	Computerized physician order entry with Clinical Decision System Support as component of electronic health record system	Duplicate medication orders increased
Van Doormaal et al (2009)	Netherlands 2008	2 Medical wards(gen. internal & gastro/rheumatology) of 1300bed University AND 2 medical wards(gen. internal & geriatric) of 600 bed hospital	Interrupted time series of measurement. 5 month pre-and 5-month post- intervention	Computerized physician order entry with Clinical Decision System Support	Large reduction in the incidence of medication errors at intervention wards; 40.3% (95% CI: -45.13%; -35.48%))

Table 1.2(continued): Characteristics of selected 42 studies

Study	Country & year	Study setting	Study design, Study period, Sample size	Type of Intervention	Outcome of intervention
Galanter et al (2010)	USA 2010	450 bed teaching hospital	Observational trial. 1011 alerts sampled in post- intervention phase. 2 month study period	Computerized physician order entry with Clinical Decision System Support employed in Electronic medical record system	Improves problem list documentation with minimal diagnostic inaccuracies
FitzHenry et al (2007)	USA 2007	Adult sub-acute, acute and critical care units of 658bed tertiary hospital.	Retrospective manual charts audits comparing expected and actual medication administration times. 4 years study period	Computerized physician order entry without electronic medication administration charting	Reduce prescribing errors but produced clinically insignificant medication administration errors
Ash et al (2007)	USA 2007	176 hospital representatives	Telephone survey of key informants	Computerized physician order entry	Positive and negative unintended consequences
Shulman et al (2005)	UK 2005	Adult Intensive care unit in University College Hospital	Prospective before- and after-data collection with intervention on medication errors. 70weeks study period	Computerized physician order entry with Hand-Written Prescription	Reduced proportion of medication errors for CPOE (4.8%) than HWP (6.7%) $p<0.04$ and an improvement in the overall patient outcome score

Table 1.2(continued): Characteristics of selected 42 studies

Study	Country & year	Study setting	Study design, Study period, Sample size	Type of Intervention	Outcome of intervention
Boling et al (2005)	USA 2005	423-bed children's hospital	Pre- (7 months) and Post-(4months) intervention. Review of medical records	Computerized physician order entry for Prescription Dose Range Checking	Clinically significant 4 fold reduction in opioid prescribing errors
Bates et al (1999)	USA 1999	3 medical units (2 general care medical units and 1medical intensive care unit) of 700 bed academic tertiary care hospital	Prospective time series analysis with 4 periods. Baseline- and post-intervention	Computerized Physician order entry with decision support features such as drug allergy and drug–drug interaction warnings	81% decrease in frequency of non-missed-dose medication errors, $p<0.0001$.
Cunningham et al (2008)	USA 2008	2 medical centres: 521-bed tertiary facility (CPOE site) and 146-bed general acute-care facility (control)	Multi-baseline, quasi experimental with non-equivalent control	Computerized Physician order entry	Faster delivery as orders were more compliant
Vardi et al (2007)	Israel 2006	18-bed multidisciplinary paediatric critical care unit of a children hospital	Prospective cohort study before- and after- study	Computerized Physician order entry with Clinical Decision Support System	Complete elimination of prescribing errors

Table 1.2 (continued): Characteristics of selected 42 studies

Study	Country & year	Study setting	Study design, Study period, Sample size	Type of Intervention	Outcome of intervention
Pharmacist's role					
Bourne and Dorward (2011a)	UK 2011	19-bed Neurocritical care unit in a teaching hospital	Prospective observational study of medication interventions. 2-week period 141 interventions	Specialist clinical pharmacist with critical care training	90% medication errors prevented.
Langebrake & Hilgarth (2010)	Germany 2010	Departments of Intensive Care Medicine and Hematology/ Oncology of University Medical centre	Prospective recordings of interventions. 2 year period study 2312 interventions	Clinical pharmacists during ward rounds and direct physician communication.	74.2% interventions triggered by pharmacist were implemented
Dashti-Khavidaki et al (2009)	Iran 2009	80- bed Nephrology and Infectious disease wards of a large University hospital	Prospective study over 12month period. 1386 records of clinical pharmacy services	Clinical pharmacy services	94.5% acceptance rate. 32% reduction in cost of pharmacotherapy
Fernández-Llamazares et al (2012)	Spain 2012	180-bed paediatric & 138-bed obstetrics and gynaecology hospital	Cross-sectional epidemiological study 3 year period. 1475 interventions	Paediatric clinical pharmacist	1391/1475 interventions accepted. 2.9% and 11.1% were extremely and very significant

Table 1.2 (continued): Characteristics of selected 42 studies

Study	Country & year	Study setting	Study design, Study period, Sample size	Type of Intervention	Outcome of intervention
Vegeland & Dyb (2008)	Norway 2008	18-bed geriatric unit of a hospital	Prospective recordings of pharmacist's proposals. 27 Selected days in a 4 year period	Clinical pharmacist participation at pre-round meetings and ward rounds	At least one drug related problem in 75% of patients. 42% resulted in change in therapy
Franklin et al (2012a)	UK 2012	475-bed teaching hospital	Before- (n=185) and after-(n=176) implementation of Imperial Model of Ward pharmacy	Ward pharmacy	Reduction of prevalence of unscreened medication orders from 7.6 % to 4.1 % (p = 0.0002)
Arrieta et al (2012)	Spain 2012	12 surgical units ,16 medical units and 14 units of university hospital	Prospective, open and descriptive study for 12 months.	Pharmacist in a centralised model	7219 interventions were recorded. Majority (73%) therapeutic exchange
Marconi & Claudius (2012)	USA 2012	Emergency department(ED) of Children's hospital	Retrospective pre- and post-intervention. 6 months charts review	ED based clinical pharmacist	Medication delays and omissions decreased by 2.3%(p<0.001)and persisted over 6months

Table 1.2 (continued): Characteristics of selected 42 studies

Study	Country & year	Study setting	Study design, Study period, Sample size	Type of Intervention	Outcome of intervention
Kelli J. Cunningham (2012)	USA 2012	87-bed paediatric teaching hospital	Prospective recordings of interventions. 2 months period. 1315 interventions	Paediatric pharmacist	Of 1976 orders, only 11(0.2%) medication errors reached the patient
Krupicka et al (2002)	USA 2002	10-bed paediatric Intensive care unit in a university affiliated children's hospital	Prospective recordings of interventions on round days. 24week study period. 172 recommendations	Paediatric clinical pharmacist	28%,26%,22% drug dosage changes, drug information, miscellaneous information respectively
Miranda et al (2012)	Brazil 2012	Emergency department of a hospital	Retrospective study of charts review. 1 year study period. 1238 interventions	Clinical pharmacist	Leads to significant therapeutic changes like duplicity, real and potential allergies, etc.
Folli et al (1987)	USA 1987	Two large children's hospital: 145-bed non-profit community hospital and 100-bed university medical centre	Prospective review of medication orders before dispensing for errors. 6 month period. 281 and 198 errors detected	Pharmacists specialized in paediatric pharmacotherapy	Errors prevented from getting to patients included over dosages, antibiotics, theophylline misuse and hyper-alimentation

Table 1.2 (continued): Characteristics of selected 42 studies

Study	Country & year	Study setting	Study design, Study period, Sample size	Type of Intervention	Outcome of intervention
Klopotowska et al (2011a)	Netherlands 2010	28-bed adult medical and surgical ICU of Academic Medical Centre	Prospective study of baseline and intervention periods. 8.5 months study period. 659recommendations made (74% consensus rate)	Hospital pharmacist trained for 4weeks in ICU	Reduction in prescribing errors (baseline, 190.5 versus intervention, 62.5 per 1000 monitored patient-days, $p<0.001$). Preventable ADEs (from 4 to 1)
Patanwala et al.(2012)	USA 2012	3 academic and 1 community Emergency Departments in geographically diverse locations	Prospective, multicentre, cohort study. 12 month period. 364 confirmed medication error interceptions	Pharmacists reviewing medication orders	Interventions affected drug therapy and 90.7% were significant, serious and life threatening.
Morato et al.(2012)	Spain 2012	300-bed private hospital	Prospective review of all prescriptions in a Computerised physician order entry. 9 month study period. 213 errors reported	Pharmacists reporting medication errors	Real and potential errors were prevented from getting to patient; 32.4% required health monitoring and 0.9% would have resulted to temporary harm

Table 1.2 (continued): Characteristics of selected 42 studies

Study	Country & year	Study setting	Study design, Study period, Sample size	Type of Intervention	Outcome of intervention
Leape et al.(1999a)	USA 1999	Medical ICU (Study site) and coronary care unit (control) of a large urban teaching hospital	Before- and after- intervention study between (baseline and after-intervention) and (intervention and control) 366 recommendations made.	Pharmacist participation on medical rounds	99% recommendations accepted by prescribers. 66% decrease with intervention group in preventable ADEs ($p<0.001$) whiles it remain unchanged with control group.
Automation					
Oswald & Caldwell (2007a)	USA 2007	613-bed acute and tertiary care university hospital	Before- and after- implementation study. Errors recorded in first dose or missing medication fill, automated dispensing cabinet fill, and inter-departmental request fill.	Automated filling and dispensing system	Filling and dispensing errors decreased from 1.6% and 0.4% to 0.6% and 0.2% respectively.
Klibanov & Eckel (2003)	USA 2003	ICU and general medicine floors of a 650-bed tertiary care teaching hospital	Post implementation study over 10 days period.	Automated dispensing	Only 0.3% pharmacy related errors, 2.3% errors in drawer placement
Bepko et al (2009)	USA 2009	Private acute care hospital	Post- evaluation of intervention	Pharmacy automation integrated with CPOE and bedside medication bar code	Reduced preventable ADEs

Table 1.2 (continued): Characteristics of selected 42 studies

Study	Country & year	Study setting	Study design, Study period, Sample size	Type of Intervention	Outcome of intervention
Computer assisted & Bar codes					
Yamamoto & Kanemori (2010)	USA 2010	Paediatric emergency and ICU departments	Paired unblinded sequential trial of medication administration calculation	Computer assisted drug administration	Reduction in errors; mean for conventional =1.8 and computer=0.7, p<0.001
Ginzburg et al (2009)	USA 2009	Multiple family medicine clinics	Retrospective reports of Pre- and post- intervention.	Automated weight based prescribing integrated in Electronic health record	Significantly more medication errors with pre-intervention group than in post-intervention group (103 versus 46, p = 0.002)
Shawahna et al (2011b)	Pakistan 2011	11 Wards of a 1280-bed teaching hospital	Prospective before- and after-intervention, reviewing inpatient records. 3300 records studied.	Electronic prescribing system	Overall reduction in error rate from 22.6% to 8.2%(p<0.01)
Patterson et al (2002)	USA 2002	Acute care and nursing home wards of 3 hospitals	Cross sectional ethnographic observational study of medication administration before- and after-intervention	Bar code medication administration	Improves anticipation and detections of errors. New paths for redesign of BCMA for patient safety

Table 1.2 (continued): Characteristics of selected 42 studies

Study	**Country & year**	**Study setting**	**Study design, Study period, Sample size**	**Type of Intervention**	**Outcome of intervention**
Poon et al (2005)	USA 2005	35-bed adult medical, surgical and ICU in a tertiary academic medical centre.	Prospective, before- and after- quasi experimental. 9 month period. 14041 administrations	Bar code electronic medication administration system (eMAR)	41.4% reduction in non-timing error rates ($p<0.001$). Timing errors fell by 50.8% ($p<0.001$)
Training & Education					
Blank et al (2011)	USA 2011	50-bed emergency department of academic tertiary care facility	Quasi-experimental nonrandomized single group, pre-post outcome study. 3-month period	Educational intervention: back-to-basic approach to reduce administration errors	Slight reduction of MAEs from 25% to 24%
Davey et al (2008)	UK 2008	30-bed children's unit in a general hospital	Retrospective analysis of inpatient drug charts pre- and post- training	Introduction of 1. Junior doctor prescribing tutorial 2. Bedside prescribing guideline.	Prescribing errors decreased by 46% with tutorials.

Table 1.2 (continued): Characteristics of selected 42 studies

Study	Country & year	Study setting	Study design, Study period, Sample size	Type of Intervention	Outcome of intervention
Martinez-Anton et al (2012)	SPAIN 2012	16-bed Paediatric ICU in a tertiary academic hospital	Prospective before- and after-intervention study. 4 months pre- and 12months post-	Education programme to improve prescription writing (good prescribing practices)	Prescribing error rate decreased from 34.2% to 21.7%
Nguyen et al (2010)	USA 2010	600-bed academic teaching hospital	Retrospective descriptive before- and after- study through review of charts	Education on the implementation of Medication Pass Time Out for nurses and physicians in administration	Rate of interruptions in administration reduced from 81% to 0 and doses of medication administered without interruption improved from 81% to 99%
Freeman et al (2013)	USA 2013	36-bed cardiac and thoracic step-down unit of a large academic medical centre	Pre- and post- intervention. 1 month period.	Unit-focused educational initiatives to reduce interruptions during medication administration	Reduction of 28 incidents of medication errors over a 3-month period

Table 1.2 (continued): Characteristics of selected 42 studies

Study	Country & year	Study setting	Study design, Study period, Sample size	Type of Intervention	Outcome of intervention
System redesign					
Cohen et al (2005)	USA 2005	489-bed non-teaching suburban community hospital	Pre- and post- intervention 3-year audit. Charts review of suspected ADEs	Full time patient safety specialist, drug protocols,	Decrease in ADEs per 1000 doses from 2.04 to 0.65($p<0.001$)
Kazandjian et al (2009)	USA 2009	35 hospitals	Retrospective cohort study. Baseline and post- intervention. 3 year period.	Design and participation in medication safety program by learning from institutional peers	Improvement in scores i.e improvement in processes leading to safer medication use

2.4.2.2 Identified Interventions

Interventions in Forty studies resulted in reduction in medication error rates. With the remaining two, study 1 reported an increase in duplication in medication orders (Wetterneck et al., 2011) and the other study (a survey of hospital heads) showed that there were negative unintended consequences with the use of CPOE (Ash et al., 2007). The identified interventions were CPOE, pharmacists' role, Automation, Computer assisted and Bar codes, Training and education and system redesign, which has been described below:

1. Computerised Physician Order Entry (CPOE)

Eleven studies discussed the impact of CPOE with or without clinical decision support systems on medication safety (van Doormaal et al., 2010, Wetterneck et al., 2011, van Doormaal et al., 2009, Galanter et al., 2010, FitzHenry et al., 2007, Ash et al., 2007, Shulman et al., 2005, Boling et al., 2005, Bates et al., 1999, Cunningham et al., 2008, Vardi et al., 2007). In 2008 colleagues from Netherlands (van Doormaal et al., 2009) found a huge reduction of 40.3% in medication errors at two medical wards with the introduction of CPOE with a clinical decision support system. Then, in 2010, they also found that CPOE helped prevent more patient harm as compared with pharmacists reviewing charts alone (van Doormaal et al., 2010). In their prospective pre- and post- observational trial, researchers (Wetterneck et al., 2011) showed that duplicate medication ordering errors increased significantly after CPOE implementation (pre: 48 errors, 2.6% total; post: 167 errors, 8.1% total). However, duplicate medication ordering errors were an example of anticipatable events based on the contributing factors identified in this study and could be easily prevented. Galanter et al.(2010) evaluated the use of CPOE with clinical decision system support employed in an electronic medical record system. The 1011 alerts sampled in the post-implementation phase showed an improvement of problem list documentation with minimal diagnostic inaccuracies. Five studies investigated CPOE without clinical support systems (FitzHenry et al., 2007, Ash et al., 2007, Shulman et al., 2005, Boling et al., 2005, Cunningham et al., 2008). Fitzhenry et al. (2007) and Boling et al. (2005) showed reduction in prescribing errors. In a 70 week prospective before- and after- intervention study to compare CPOE with hand- written prescribing (HWP), Shulman et al.(2005) showed a reduction in the proportion of medication errors for CPOE (4.8%) than HWP (6.7%) and an

improvement in the overall patient outcome score. A quasi experimental study using a tertiary facility for CPOE site and an acute care facility for control reported fast delivery with better compliant orders than control (Cunningham et al., 2008). Ash et al. (2007) used telephone survey to obtain views from key hospital informants. Respondents mentioned various unintended consequences including new work, workflow, system demands, communication, emotions, new kind of errors, power shifts and technology dependence. However, after several years of CPOE being place (between 6months-25years), the median percentage of orders entered electronically was 91%.

2. Pharmacist's role

There were sixteen studies (Bourne and Dorward, 2011b, Langebrake and Hilgarth, 2010, Dashti-Khavidaki et al., 2009, Fernández-Llamazares et al., 2012, Veggeland and Dyb, 2008, Franklin et al., 2012a, Arrieta et al., 2012, Marconi and Claudius, 2012, Cunningham, 2012, Krupicka et al., 2002, Miranda et al., 2012, Folli et al., 1987, Klopotowska et al., 2011a, Patanwala et al., 2012, Morató et al., 2012, Leape et al., 1999b) on the roles of pharmacists. These studies showed different roles pharmacists play in medication safety. The only study that compared a study group with a control was that of Leape et al. (1999a). Their study compared preventable adverse drug events in a 17 bed medical ICU with a 15 bed coronary care unit of a large urban teaching hospital with no pharmacist participating on medical rounds as a control on the coronary unit. In the medical ICU, the rate of preventable prescribing adverse drug events (ADEs) decreased from 10.4 to 3.5 events per 1000 patient-days ($P < 0.001$), while no significant changes were observed in the control unit (10.9 vs. 12.4 per 1000 patient days, $P > 0.05$). These resulted in a 66% decrease of ADEs. There was also a 99% acceptance of pharmacists' recommendations by prescribers. In 2 retrospective chart reviews, Marconi and Claudius (2012) showed that an Emergency Department (ED) based clinical pharmacist had decreased medication delays and omissions by 2.3% whiles Miranda et al. (2012) reported that 1238 interventions by ED based pharmacist over a one year period reduced duplicity and potential allergy errors. Bourne and Dorward (2011b) reported the prevention of 90% medication errors by neurocritical care specialist pharmacists in a prospective observational study. A study also reported that a paediatric specialist pharmacist prevented 11.1% of extremely significant medication errors from reaching the

patients in a 180-bed paediatric and 138 bed obstetrics and gynaecology hospital (Fernández-Llamazares et al., 2012). Franklin et al.(2012b) studied the before- and after- implementation of a model of ward pharmacy. There was a reduction of prevalence of unscreened medication orders from 7.6% to 4.1% though there was no change in the prevalence of dose omissions. In an 8 months prospective study, Klopotowska et al. (2011a) evaluated prescribing errors in a 28 bed adult medical and surgical ICU before and after pharmacist participation at patient review meetings. With pharmacist participation, prescribing errors reduced from 190.5 per 1000 patient-days to 62.5 per 1000 patient-days ($P < 0.001$). Folli et al. (1987) examined review of medication orders before dispensing over a 6 month period by pharmacists. Errors prevented included overdosages, antibiotics and theophylline misuse etc. Morato et al. (2012) studied the prospective review of all prescriptions in a computerised physician order entry. They found that real and potential errors were prevented from getting to patients with 32.4% requiring health monitoring whiles 0.9% would have resulted in temporary harm. Another study also prevented 90.7% significant, serious and life threatening medication errors when pharmacists reviewed orders in prospective, multicentre cohort 12 month study (Patanwala et al., 2012).

3. Automation

Three studies identified the effect of automated pharmacy systems (Klibanov and Eckel, 2003, Oswald and Caldwell, 2007a, Bepko et al., 2009) of which 2 were on automated dispensing. Oswald and Caldwell (2007b) evaluated the effect of automated filling and dispensing system in a 613 bed acute and tertiary care university hospital. Filling and dispensing errors decreased from 1.6% and 0.4% to 0.6% and 0.2% respectively after the implementation. Klibanov and Eckel (2003) however found inappropriate charging of medications, increased pharmacy workload, and incorrect loading of medications associated with their dispensing technology. Their study did not evaluate the benefits of the system and data collected was not representative (10 out of 65 cabinets were inventoried) and was carried out over too short a period (10 days). A study by Bepko et al.(2009) examined the effect of pharmacy automation integrated with CPOE and bedside medication bar code technology in an acute care hospital. The study showed the vulnerabilities of a manual system approach to the medication process. Medication variance reduced from 2.9% to zero post implementation.

4. Computer assisted and Bar codes

The effect of computer assisted and bar code technologies were examined in 5 studies (Yamamoto and Kanemori, 2010, Ginzburg et al., 2009, Shawahna et al., 2011a, Patterson et al., 2002, Poon et al., 2010). Yamamoto and Kanemori (2010) investigated computer assisted drug administration calculation using a paired sequenced trial in a paediatric emergency departments. A mean of 1.8 errors was recorded with the conventional manual method as compared with the computer program with a mean of 0.7 errors (95% CI about mean difference is 0.6 to 1.7, p< 0 .001). Ginzburg et al.(2009) retrospectively examined the pre- and post- implementation of a weight based prescribing method integrated in electronic health record system. There were significantly more medication errors found in the pre-intervention group than in the post-intervention group (103 versus 46, p = 0.002). In addition, significantly fewer strength overdosing errors occurred in the post-intervention group (8.9% versus 4.0%, p =0.028). Shawahna et al. (2011a) studied the effect of an electronic prescribing on errors in a 1280-bed teaching hospital in a prospective review of medication and discharge charts. The overall reduction in error rate decreased from 22.6% to 8.2% (p<0.01). The effect of bar code technology on medication administration (MA) was examined in two studies. Poon et al. (2010) undertook a 9 month prospective, before- and after- quasi experimental study in a 35-bed adult medical, surgical and ICU in a tertiary academic medical centre. The introduction of a bar code electronic medication administration system resulted in 41.4% reduction in non-timing MA rates (p<0.001) whiles timing ME fell by 50.8% (p<0.001). Patterson et al. (2002) found an improvement in anticipation and detection of errors though they concluded that there were side effects following the introduction of Bar Code Medication Administration which might create new paths to adverse drug events.

5. Training and education

Five studies discussed the effects of training and educational programmes. Davey et al. (2008) found that after the introduction of junior doctor prescribing tutorial and bedside prescribing guideline, prescribing errors decreased by 46%. Martinez-Anton et al. (2012) compared a 4-month pre- to 12-month post- implementation of interventional programme in a16-bed paediatric ICU of a tertiary academic hospital. The interventional program included

four measures: standardization of prescription sources, pocket tables with dosing guidelines, an updated prescription protocol, and an educational program on correct prescribing. After reviewing hand written prescriptions for both periods, prescribing error rate reduced from 34.2% to 21.7 % after the intervention. There were also two studies that reported a reduction in medication administration errors. Nguyen et al. (2010) examined the implementation of Medication Pass Time Out, an educational programme for nurse and physicians on medication administration. After 6 months and 1 year of the intervention, the rate of interruptions during the medication administration process decreased from 81% to 0 whiles the percentage of doses of medication administered without interruption improved from 81% to 99%. Medication doses administered without errors at baseline, 6 months, and 1 year improved from 98% to 100%. In another study at a 36 bed step-down unit using unit focused educational initiatives to reduce medication administration interruptions, researchers found a reduction of 28 incidents of medication errors over a 3-month period (Freeman et al., 2013). Blank et al. (2011) showed a slight reduction of medication administration errors from 25% to 24% after instituting a back-to-basic educational approach in a quasi-experimental nonrandomized single group study.

6. System redesign

Two studies (Cohen et al., 2005, Kazandjian et al., 2009) were identified involving strategies for redesigning medication use systems. A 489-bed non-teaching suburban community hospital assigned a full time patient safety specialist and Cohen et al. (2005) found out that there was a decrease in adverse drug events of 2.04 per 1000 doses to 0.65 per 1000 doses ($p<0.001$). Kazandjian et al. (2009) evaluated a MEDSAFE Project, a state-wide medication safety projects using a retrospective cohort study of 35 participating acute hospitals using a weighting structure. The statewide aggregate score significantly increased from 74.2% to 81.2% ($p<0.05$) after the 2 years of implementing the project.

2.4.3 Strategies to Improve Medication Use Process

Medication use safety will involve processes regarding the stages in prescribing, dispensing and administration.

Prescribing

Of all types of medication error, prescribing error is the most serious (Barber et al., 2003). This is because once an error has been made, unless detected, it will be systematically applied and can result in significant harm or death. Interventions are therefore aimed at preventing their occurrence. Computerized physician order entry (CPOE) has been found to reduce prescribing errors in hospital settings (van Doormaal et al., 2009, Reckmann et al., 2009, Hug et al., 2010, Ammenwerth et al., 2008b). CPOE equipped with clinical decision support (CDS) has been shown to enhance their usefulness as some offer drug-drug interactions checking and advanced guidance for laboratory testing. A study by Bates et al. (Bates et al., 1999) demonstrated a reduction in the rates of both total ADEs and preventable ADEs per 1,000 patient-days with the use of CPOE with CDSS. The trend in total ADEs non-significantly fell from 14.7 to 9.6 between the baseline and the third study period and the trend in preventable ADEs significantly decreased from 2.9 in the baseline period to 1.1 in the third study period (P=0.05). Paediatric populations are more susceptible to medication errors in hospital settings with incorrect dosing contributing significantly (Gonzales, 2010). van Doormaal et al. (2009) also evaluated the implementation of a CPOE with CDSS system for patients 65 years of age or older on the rate of ADEs measured. It led to a significant immediate absolute reduction of 40.3% (95% CI: - 45, -36%) of medication orders with one or more errors.

Though CPOE has also been touted as a viable solution to many prescribing problems, there are some limitations to its use. The installation of these systems is costly (millions of dollars) and requires major behavioural changes, not only by physicians, but also by the entire health care organization (Berger and Kichak, 2004). The increased time required by physicians to enter data into CPOE products will result in increased personnel costs for direct patient care. The cost associated may be prohibitive for resource constraint countries like Ghana. In the Harvard studies, CPOE also appeared to increase the incidence of actual serious ADEs, particularly during the early years of implementation of such systems (Bates et al., 1999).

The medical informatics community will continue to rigorously study CPOE systems as they become integrated, along with other medical software, into the daily delivery of clinical care. It is certainly possible that as CPOE systems mature in the future, true benefits can be shown from their implementation.

Involving pharmacists in early stages of medication ordering has been shown to contribute to safety. In a prospective observational 2-week study of medication interventions done by a specially trained clinical pharmacist, medication errors were reduced by 90%(Bourne and Dorward, 2011b). In a 80-bed nephrology and infectious units, Dashti- Khavidaki et al. (2009) found that the introduction of clinical pharmacy services reduced errors in pharmacotherapy by 32%. Arrieta et al. (2012) also found that the incorporation of pharmacist in clinical patient management led to a 73% therapeutic exchange. Continuous training of prescribers has been shown to be useful. Paediatric junior doctors were given prescribing tutorials and bedside guidelines and prescribing errors rates decreased by 46% (Davey et al., 2008). Martinez -Anton et al. (2012) studied the effect on error rates by combining standardization of prescription sources, pocket tables with dosing guidelines, an updated prescription protocol, and an educational program on correct prescribing. There was a significant reduction of error rates from 34.2% to 21.7%.

Dispensing

Pharmacy automation has been shown to decrease dispensing errors, improve workflow and inventory control, and ease pharmacists' distributive responsibilities (ASHP, 1998). It also has the potential to improve the quality of patient care itself and also by freeing up health care professionals to perform tasks that improve patient care in other ways (Bepko et al., 2009). The various options available in hospital pharmacy setting include automated dispensing cabinets, automated mobile medication carts, automated pharmacy carousel systems and robotic picking systems. Oswald and Caldwell (2007a) conducted a study on automated pharmacy carousel system and found out that, it decreased filling and dispensing error rates from 1.6% and 0.4% to 0.6% and 0.2% respectively. Since automation presents pharmacists with fewer filling errors, the likelihood of a dispensing error is also less. Klibanov and Eckel (2003) studied the value of automated dispensing technology by evaluating charging, inventory control, pharmacy workload, and the potential for medication errors. Their system was a computer controlled dispensing device that stores and controls drugs directly on the nursing unit. Medications were available to nurses only after physician orders have been entered into the pharmacy computer system and verified by a pharmacist. The intervention resulted in only 0.3% pharmacy-related medication errors. However,

inappropriate charging of medications, increased pharmacy workload, and incorrect loading of medications were problems associated with the system.

Medication administration

At the bedside, the use of bar-code technology to verify a patient's identity and the medication to be administered is a promising strategy for preventing medication errors, and its use has been increasing (Wright and Katz, 2005). Poon and colleagues (2010) evaluated bar code eMAR technology on timing and non-timing administration error. Using a prospective, before-and-after, quasi-experimental study design, they compared error rates in units that were using the bar-code eMAR technology with the rates in units that had not implemented it. There was a significantly 41.4% relative reduction in errors. Medication delays and omissions also decreased significantly by 2.3% when clinical pharmacist was introduced in an emergency department to actively review medication charts (Marconi and Claudius, 2012). Another study (2007) found that ward-based medication administrations do not consistently occur as ordered even after implementing CPOE and bar-coded medication administration. These discrepancies are likely to persist unless recommended interventions are made to address issues such as determining the true urgency of medication administration, avoiding overlapping duplicative medication orders, and developing a safe means for shifting dosing schedules.

Marconi and Claudius (2012) evaluated the impact of adding a clinical pharmacist within a paediatric emergency department on medication omissions and delays, as well as medication errors on patients. Medication omissions and delays decreased significantly immediately from 52.8% to 28.6% and 36% respectively. Pharmacists, in inpatient settings, improve the accuracy of medication administration. Pharmacies within hospitals not only dispense medications, but also are a direct resource for physicians and nurses at preventing medication administration errors. Training initiatives that tend to reduce interruptions and distractions are sustainable at improving the processes in medication administration (Nguyen et al., 2010). Nguyen and colleagues (2010) evaluated whether a medication safety initiative, known as Medication Pass Time Out in a pilot unit in hospital was effective and sustainable in reducing medication administration errors. The initiative involved training nurses to observe a protected hour early in a shift during medication administration with no interruptions (i.e.

time out). The goal during this time was for a nurse to focus exclusively on reconciling medication orders, administering medications, checking medication labels, and charting the administration of medications. Medication doses administered without errors at baseline, 6 months, and 1 year improved from 98% to 100%.

Studies have shown that paediatric patients are more vulnerable to drug administration errors due to a lack of appropriate drug dosages and strengths for use in this group of patients (Chua et al., 2010, Kaushal et al., 2001). Compared to fixed-dose single-vial drug administration in adults, paediatric drug dosing and administration requires a series of calculations, all of which are potentially error prone. Computer-assisted dosage calculation approach was shown in a study by Yamamoto and Kanemori (2010) to reduce errors and time required for drug administration calculations.

These challenges in the medication use processes require effective strategies to improve safety in patient care.

2.5 Medication Safety Activities of Pharmacists

Various researchers have identified numerous interventions to improve medication safety (Franklin et al., 2007, Ammenwerth et al., 2008a, Kaushal et al., 2003, Lainer et al., 2013, Bepko et al., 2009, Farbstein and Clough, 2001, Hassan et al., 2010a, Foote and Coleman, 2008). Significant among medication safety interventions is the role of pharmacists in maximizing the safe, effective, and efficient use of medicines (Bourne and Dorward, 2011b, Christen, 2006, Ho et al., 2013, Veggeland and Dyb, 2008, Koren et al., 1991). Since the adequate care of hospitalized patients depends largely on use of drugs, more professional involvement of well-motivated and trained pharmacists should benefit these patients. Bond and Raehl (2008) showed that pharmacy practice has the propensity to improve patient outcomes, reduce rates of adverse events and mortality, and maintain value over time. They thus recommended that hospital pharmacy directors and clinical coordinators allocate pharmacists to incident prone areas in the medication use system to reduce the risk of harm from medicines. The training of pharmacists affords them the skills and competence to detect and or prevent medication incidents and reduce their potential harm to patients. Pharmacists provide patient care that optimises medication therapy and promote health, wellness and

disease prevention. They can particularly be well positioned to provide the necessary medication instruction to patients as prescribed by the IOM's report.

Pharmacists are uniquely trained in therapeutics and provide comprehensive drug management to patients and healthcare providers including physicians, nurses and others. The Institute of Medicine report *To err is human* recognized that pharmacists are an essential resource in safe medication use, that participation of pharmacists on ward-rounds improves medication safety in hospitals, and that pharmacist-physician-patient collaboration is important (Kohn et al., 2000b).

Pharmacists serve mostly as preventive strategy for improving medication use in most stages of the medication use process. There is growing evidence of the positive impact of clinical activities of pharmacists on patient outcomes through reductions in medication-related adverse events, lower treatment costs, better patient outcomes, reduced length of stay and reduced readmission rates (Smith, 2004, Kohn et al., 2000a, Kucukarslan et al., 2003). Nevertheless, there still do not exist tools for evaluating the productivity of the clinical services provided by pharmacists (Rough et al., 2010).

2.5.1 Adverse Drug Event Detection

2.5.1.1 Pharmacy ward rounds

The ward pharmacy system places the pharmacist in a good position to detect adverse drug events (ADEs) and address pharmaceutical care needs of patients. Studies have investigated the positive effect of on-ward pharmacy services. Inappropriate prescribing in an elderly hospital population was recovered (Kaur et al., 2009a, Viktil and Blix, 2008). There were reductions in preventable ADEs in other various hospital patient populations (Kucukarslan et al., 2003, Leape et al., 1999a, Kaboli et al., 2006b). In a single-blind, standard case–controlled study which compared patients receiving care from a ward rounds team including a pharmacist with patients without, there was a 78% reduction in the rate of preventable ADEs (from 26.5 per 1000 hospital days to 5.7 per 1000 hospital days) (Kucukarslan et al., 2003). At ward rounds patient decisions are made. This gives pharmacists opportunity to intervene in many errors that would have occurred. Though pharmacists attending ward rounds with medical teams has become routine in some hospitals, it is still not a familiar

practice in most countries especially developing countries (Klopotowska et al., 2011b). As part of its recommendations, the IOM states that pharmacists should be included in ward round teams as one strategy to improve medication safety (Kohn et al., 2000b).

The principal cause of prescribing errors is insufficient information when the prescribing decisions are made (Bates et al., 1995c). The prescribing decisions in teaching institutions are often made during ward rounds and this is the step in the patient care process in which the pharmacist may contribute to improving the quality of patient care. During ward rounds, pharmacists would be able to recommend medication, doses, and monitoring parameters for the patient and these recommendations are effected when these decisions are made.

2.5.1.2 Medication Chart Review

In other clinical settings like the emergency department, there is often no formal patient care rounding, but pharmacists may be consulted for specific issues or be present when drug therapy decisions are being made (Patanwala et al., 2012). It is possible that these latter activities have a greater influence on patient safety. Though medication order review is a time-consuming task, it has been proven to yield good results of identifying a lot of medication errors (Leape et al., 1999a, Kaushal, 2002). Moreover, in most practice settings where the pharmacist is placed distant from the medication selection step of the patient care process, chart review will be the viable option to address medication use challenges. Interventions will involve recommendations to adjust doses, to add or delete drugs, to monitor laboratory values, or to identify potential problems at discharge and to provide responses in as much a timely manner as possible.

There is growing evidence from countries such as the United States that electronic prescribing systems with inbuilt clinical decision support may contain features that protect against error and thus enhance patient safety (Bates et al., 1999). However, similar evidences suggest that they may also introduce new risks of their own (Redwood et al., 2011, Shulman et al., 2005, Reckmann et al., 2009). This risk would require a review of some sort. Pharmacists thus review electronic charts and verify them before medicines are administered.

2.5.1.3 Medication Reconciliation

Medication reconciliation refers to the completion of the best possible medication history and the act of correcting any unintended discrepancies between a patient's previous medication regimen and the proposed medication orders at admission (from home or a health care facility, such as a nursing home), inpatient transfer (to or from other services or units, such as the intensive care unit), or discharge (to home or a health care facility) (Kwan et al., 2013). Transitions in patient care, such as admission to and discharge from the hospital, put patients at risk for medication errors due to poor communication and inadvertent information loss (Kripalani et al., 2007). Usually, one of the studied contributors to this challenge is the unintentional changes to patients' medication regimens (Coleman et al., 2005, Tam et al., 2005) which often differ at hospital discharge from preadmission medications. Though some differences reflect deliberate changes related to the conditions that led to hospitalization other discrepancies are unintentional and result from incomplete or inaccurate information about current medications and doses. A systematic review showed that up to 67% of patients admitted to the hospital have unintended medication discrepancies (Tam et al., 2005), and these discrepancies remain common at discharge (Coleman et al., 2005). Invariably, this formal process for identifying and correcting unintended medication discrepancies across transitions of care, has been widely endorsed by World Health Organisation (2006) and is mandated by health care bodies in the UK (Audit Commission, 2001), United States (Joint Commission (1951) and Canada (Accreditation Canada (2012). Pharmacists undertake most of medication reconciliation in hospitals and most unintended discrepancies are identified resulting in improved care transitions (Kwan et al., 2013).

2.5.2 Benefits of Hospital Pharmacists' Activities

Involving pharmacists in the care of hospital patients decreases drug-related healthcare costs (Bond et al., 1999), prevents adverse drug events (Bond and Raehl, 2006, Bond et al., 2001), reduce mortality (Bond et al., 2001) and improves the quality and efficiency of patient care.

2.5.2.1 Health Cost Savings

The contribution of pharmacists to patient care by ensuring rational prescribing, result in the reduction of drug therapy cost. There was a total reduction of drug therapy cost with an average saving of 35.8% after applying pharmacy practices in an ICU over a period of ten months (Aljbouri et al., 2012). The cost associated with ADEs is substantial to hospitals and therefore justifies the importance of recruiting pharmacists to prevent their occurrences (Bates et al., 1997).

Pharmacists also prevent hospital readmissions, which may contribute to healthcare cost savings. A study revealed that of 65 patients in the control group, 28 (43.1%) were readmitted to the hospital within 60 days of discharge compared with 12 of 66 (18.2%) intervention group, patients receiving pharmacy services (P = 0.0020) (Bellone et al., 2012). In another study, patients who received medication therapy assessment and reconciliation by pharmacists had decreased readmission rates at 7, 14, and 30 days post-discharge (Kilcup et al., 2013). In their study, medication review versus comparison readmission rates were as follows: 7 days: 0.8% vs. 4% (p = 0.01); 14 days: 5% vs. 9% (p = 0.04); and 30 days: 12% vs. 14% (p = 0.29). Moreover, their study concluded that financial savings per 100 patients who received medication reconciliation was an estimated $35,000, translating to more than $1,500,000 in savings annually.

2.5.2.2 Mortality Rate Reduction

Another very important contribution of pharmacy to healthcare is their role in reducing morbidity and mortality rates. It has been shown that mortality rates decrease as the pharmacist-to-occupied bed ratio increases and the primary factor contributing to this beneficial association is the involvement of pharmacists in the direct care of patients (Bond and Raehl, 2007b). MacLaren and colleagues (2008) compared mortality rates of ICUs with and without pharmacists. Mortality rates in ICUs without pharmacists were higher by 23.6% ($p < 0.001$, 386 extra deaths), 16.2% ($p = 0.008$, 74 extra deaths), and 4.8% ($p = 0.008$, 211extra deaths) for nosocomial-acquired infections, community acquired infections, and sepsis, respectively. Similarly, ICU length of stay was longer by 7.9% ($p < 0.001$, 14,248 extra days), 5.9% ($p = 0.03$, 2855 extra days), and 8.1% ($p < 0.001$, 19,215 extra days) for nosocomial-acquired infections, community-acquired infections, and sepsis, respectively.

2.5.2.3 Patient Satisfaction and Quality of Life

Quality of health care provides a safe, effective, patient centred, timely, efficient, and equitable service. After the report by the Committee on Quality of Health Care in America (2001), improved quality and efficiency of pharmaceutical care have become overarching goals of pharmacy services in most hospitals. Patient satisfaction is one important indicator of the quality of care because it reflects whether or not a given service is meeting patients' expectations and is consistent with their values (Donabedian, 1988). Therefore healthcare organizations include patient satisfaction as an indicator of service quality and it contributes to generation of confidence in healthcare (Carey and Seibert, 1993). Several studies have found improved patient satisfaction with pharmacists playing active roles in hospital (Khudair and Raza, 2013, Oparah et al., 2004, McKee et al., 2011, Dussart et al., 2009, Johnson et al., 1999, Kradjan et al., 1998, Marshall et al., 1997).

Healthcare systems benefit from pharmacists. Pharmacists spend different times on the different types of hospital services. They will spend more time on the activities they perceive offer the greatest benefit to their patients. It will therefore be useful to understand the different types of services hospital pharmacists offer and their perceived importance to enhancing medication safety.

2.5.3 Clinical Interventions of Pharmacist

The clinical value of pharmacist's intervention and its positive contribution to the quality of pharmacotherapy has been confirmed in literature (Buurma et al., 2004, Leape et al., 1999a, Langebrake and Hilgarth, 2010). For example, in an acute care geriatric unit, 76 interventions were made in 3-month period in pharmacotherapy areas that included drug selection, dosing, changes in therapy, and medication reconciliation (Reilly et al., 2012). Moreover these interventions by the pharmacists have been considered as a valuable input by the health care community in the patient care process by rationalising and reducing cost of therapy (Al Rahbi et al., 2014). There has also been evidence of an improvement in adherence to national clinical practice guidelines and optimizing the pharmacy benefit for the elderly (Hanlon et al., 1996). Pharmacists performed better than the clinical decision support system in identifying drug–drug interactions (Cornu et al., 2014). Increasingly evidence supports involvement of a

pharmacist increases knowledge and awareness of medication-related issues for other healthcare professionals (Kaur et al., 2009b).

The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has recommended that all prescriptions must be reviewed by pharmacists before dispensing and stressed that the outcomes should be documented as a result of direct patient care by the pharmacy (Davydov et al., 2003). Documentation of the interventions is important for justifying pharmacists' services to the patient, healthcare managers and providers, patient care takers, to strengthen the profession (Smith, 2009). The tenets of pharmaceutical care suggest that pharmacists should document, at the very least, the actual or potential medication-related problems identified, as well as the associated interventions that they desire to implement or have implemented (Hepler and Strand, 1990, Oparah and Eferakeya, 2005). The pharmacist must adequately communicate his or her recommendations and actions to non-pharmacy health care practitioners (e.g., doctors, nurses), the patient or caregiver (e.g., parents), or other pharmacists. The goal is to provide a clear, concise record of the actual/potential problem, the thought process that led the pharmacist to select an intervention, and the intervention itself. To effectively undertake these activities, pharmacists need to work collaboratively with the other health professionals.

2.6 Collaborative Working Relationship (CWR)

Collaboration is described as high level co-cooperativeness and assertiveness to solve problems where there are common interests and the stakes are high (Thompson, 1976). Patient care is a shared responsibility of trained health professionals. Several studies have evaluated pharmacist-physician team management of drug therapy and have reported improvements in blood pressure (Bogden et al., 1998), diabetes outcomes (Coast-Senior et al., 1998), cholesterol levels (Bluml et al., 2000a, Bogden et al., 1997) and depression (Boudreau et al., 2002b). Moreover, from the perspective of the nurse practitioners, the integration of pharmacists into the clinical teams was felt to have facilitated positive patient outcomes by improving team drug-therapy decision-making and continuity of care (Makowsky et al., 2009).

To have a positive impact on patient outcomes achieved with drug therapy and ensure medication safety, pharmacists will have to work more closely with physicians and nurses to manage medications.

A systematic model with 5 stages of collaboration has been developed by McDonough and Doucette (2001) to enhance working relationships between pharmacist and other health care professionals . At stage 0, there is virtually no interaction between the doctor or nurse and the pharmacist. For any further movement to the next stage, Baggs and Schmitt (1997) identified that pharmacists should be in close proximity, possess appropriate clinical knowledge and be receptive to collaboration. Stage 1 typically begins with exchange initiated by the pharmacist in creating awareness. At this stage, pharmacists see the relationship as necessary for the success of their new clinical service, although the others may not see the value of the need to establish working relationship. As the relationship develops, interdependence increases and communication becomes bilateral. At stage 4, commitment to the CWR has been achieved, mutual trust and respect have been established and both parties work to maintain the relationship. Reaching commitment will be more likely if the exchange efforts by parties are close to equitable. As doctors for example, rely on the knowledge and skill that pharmacists have displayed during the early stages of CWR, pharmacists will rely on the clinical information physicians provide in aid of patient's drug therapy choices.

In improving CWR, the model will serve as a useful guide. In the professional relationships between pharmacists and others, it is acknowledged that each practitioner possesses a set of individual characteristics that affect his or her willingness to accept the changes and risks involved in developing collaboration. A physician or a nurse familiarity with pharmacist's abilities support his or her willingness to accept the pharmacist's input (Bradshaw and Doucette, 1997). Collaboration is more likely to occur when each practitioner view the risk to their own practice as low and the value added as high.

There are variables that impact on the development of a collaborative working relationship: individual, context, and exchange characteristics (Zillich et al., 2004). Individual variables are characteristics of the individual practitioners and include demographics, training, and psychological traits. Context variables represent the environment in which the practitioners interact; this includes practice setting and professional interactions among practitioners. Exchange variables refer to characteristics of the exchanges between the practitioners and

illustrate the extent of the relationship between the doctor or nurse and the pharmacist (attraction, trust, communication, power and justice, norm development, conflict resolution and dependence). In a primary care study of pharmacists and other practitioners, Zillich et al. (2004) reported that exchange factors were especially important in developing collaboration between practitioners. Specifically, they reported that trustworthiness, role specification, relationship initiation, and professional interactions were positively associated with collaborative care. Effective collaboration requires commitment from all practitioners involved. McPherson et al. (2001) also mentioned good communication, appropriate training and access to needed resources as important factors for successful collaboration.

Practitioners who perceive greater value from pharmacist's contributions are more likely to find an expanded role for pharmacists attractive (Bradshaw and Doucette, 1997). If practitioners only communicate by telephone or fax, they may never become comfortable enough with each other to establish true CWRs. Pharmacists should increase face to face visits which will provide opportunities for them to be comfortable with other practitioners. During these visits, information is exchanged. When each allows the other to assess their performance, they help build trust and develop satisfaction. The formation of relational norms such as reciprocity and solidarity among practitioners can also support collaboration (McDonough and Doucette, 2001). These norms will be influenced largely by the perceptions and opinions that doctors and nurses and other practitioners have on pharmacists' roles in medication safety. When collaboration between health care professionals improves, there is also an improvement in their perceptions about each other (Vazirani et al., 2005).

2.6.1 Perceptions Towards Pharmacists' Role

Doctors and nurses appear to have high expectations of pharmacists in hospitals and regard pharmacists as knowledgeable drug-therapy experts (Gillespie et al., 2012, Azhar et al., 2012). Studies conducted in the Netherlands (Muijrers et al., 2005) and Qatar (Zaidan et al., 2011) investigating the opinions of physicians and others toward pharmacists' professional duties showed that overwhelming percentage of the respondents perceived pharmacists should have an input in the patient's pharmacotherapeutic plan and should participate in the pharmacotherapy audit meetings. However previous studies have demonstrated that physicians are more reluctant to accept pharmacists' roles, which include any aspects of

prescribing (Bailie and Romeo, 1996, Spencer and Edwards, 1992). Such discomfort may be due to many reasons, one of which is that of the lack of routine interactions with pharmacists. This lack of interaction between physicians and pharmacists is thought to make physicians reluctant to approve and accept more clinical duties for pharmacists. Physicians and nurses are more likely to accept traditional roles of pharmacists. However, a study concluded that doctors and nurses were satisfied with the new collaboration with the hospital based pharmacists and perceived that the quality of the patients' drug therapy and drug-related patient safety had increased (Gillespie et al., 2012).

Doctors and nurses are among the key players in the medication use process and their views are valuable for pharmacists in the creation of medication safety culture in hospitals. Consequently, doctors' and nurses' acknowledgement and understanding of the skills and knowledge of pharmacists to take up and operationalize these shared patient safety activities is essential.

Chapter 3

3 Methods

This chapter details a description of the various methods used for this study including ethical approval. This section has been sequentially arranged in four parts. Each part begins with the description of the study design, study setting and the data collection process. Other sources of data are also discussed. Finally, the tools used to analyse the data is provided for each part of the study method.

3.1 Ethical Approval

Institutional approvals were obtained from the Internal Research Ethics Board of the Public Health Unit of Korle Bu Teaching Hospital (Appendix 3.1) and the Ethical and Protocol Review Committee of the University of Ghana Medical School (MS-Et/M.3 – P 3.1/2013-2014) (Appendix 3.2).

3.2 Section One: Medication Administration Errors

3.2.1 Study Design

This part of the study was divided into two phases. The second phase of the study followed almost immediately. The first phase involved a direct, cross sectional non-participant observations of medication administration by nurses at the ED. The second phase involved a face- to- face interview. The observational method of study has been widely employed by many researchers in similar studies (Dean and Barber, 2001, Flynn et al., 2002, Chua et al., 2010, Ghaleb et al., 2010). Researching medication administration errors using the observation technique dates back to the early 1960s with research by Barker (Armitage and Knapman, 2003). In using observation as a scientific methodology, an observer is essentially assigning numbers to a human behaviour. With this method, the administering of medications to patients observed independent of the subject's knowledge of the given situation. In this way, the subject's willingness to report as with self-reporting is eliminated as an obstacle to data collection (Barker, 1980) . Unlike, experimental studies, this enables individuals to be watched under their normal working environment so that the details of the problem can be well elucidated (Kopp et al., 2006). This is best done when observers behave more discreetly and observe over a longer period of time for subjects to return to their normal habits after being introduced.

3.2.2 Study Setting

This part of the study was conducted in the 50 bed adult Surgical and Medical Emergency department of Korle Bu Teaching Hospital (ED). Korle Bu Teaching Hospital (KBTH) is a 2000 bed tertiary care teaching hospital in Accra, the capital of Ghana. The hospital had an average daily attendance of 1500 patients and about 250 patient admissions. With specialised facilities, it served as a referral centre for the West-African sub region. The ED had been arranged into a reception and four wards of varying capacities. It served non-trauma adult emergency cases of surgical and medical nature. Prescriptions were hand written onto treatment sheets, which served as orders for nurses in their administrative functions. Medications were obtained from either the ED pharmacy by nurses or other units/outside the hospital by carers. Few emergency medications could be obtained directly at the reception. On the wards, medications were stored by patients' in bedside lockers.

3.2.3 Phase I: Prevalence of MAEs

3. 2.3.1 Definition of Medication Administration Error Used

This study defined an administration error to have occurred when what was administered differed from what had been prescribed (Dean, 1999, Flynn et al., 2010, Agalu et al., 2012). This included drug admixtures done by nurses before administrations as it was the work of nurses other than pharmacy staff to prepare drugs for administration. However, medication written as '*prn*' (as needed) were excluded. Medication administration errors were classified into eight categories: Omission, Unauthorised drug, Wrong time, Wrong drug preparation, Wrong dose, Wrong dosage form, Drug deteriorated and Wrong administration technique (Table 3.1).

Table 3.1: Error categories and their descriptions (van den Bemt et al., 2009)

Error Category	Description
Omission	It was defined as a failure to administer an ordered drug to a patient. This included patient refusing their medication and unavailability of the medication.
Unauthorised drug	It was the administration of a drug that was not prescribed for the patient concerned. This included medications that were not on patients' medication charts and was administered.
Wrong time	This was defined as a dose administered more than one hour before or after the specified time.
Wrong drug preparation	It included incorrect dilution or reconstitution, mixing drugs that are physically incompatible and inadequate product packaging
Wrong dose	It was the administration of the correct drug by the correct route but in a quantity that was not that prescribed (includes administration of incorrect number of dose units, selection of the wrong strength, and the measurement of an incorrect volume of an oral liquid). Where liquid preparations are not measured but instead poured into ungraduated medicines cups. If failure to shake a bottle of suspension resulted in a visible concentration gradient this was also considered a wrong dose error.
Wrong dosage form	This error type included the administration of the correct dose of the drug by the correct route but in a formulation that was not prescribed (includes administration of a modified release when non-modified prescribed, and vice versa).
Drug deteriorated	It was the administration of a drug that has exceeded its expiry date or a drug with its physical or chemical integrity compromised.
Wrong administration technique.	This included doses administered via the wrong route (different from the route prescribed), via the correct route but at the wrong site, and at the wrong rate of administration.

3.2.3.2 Error Rate Calculation Rule

The medication administration error rate was the ratio of the number of errors to the total opportunities for errors (TOE) expressed as a percentage. TOE was defined as the total number of ordered doses and unordered doses administered to patients (Allan, 1987, Berdot et al., 2012). For this study, more than one error per dose was possible and taken into account in the calculation of TOE. Error rates were calculated with or without wrong time error as

recommended by Allan and Barker (1990) and also including and excluding lack of drug availability.

3.2.3.3 Data Collection

Nurses were informed about the study with an invitation letter (appendix 3.3) and those who accepted the invitation to participate were supplied with information for consent (appendix 3.4). They then completed consent forms (appendix 3.5) before participating. To ensure observer reliability, a single clinical pharmacist was trained to collect the data. The observer followed nurses preparing and administering medications during scheduled drug rounds from the 1st of November 2012 – 28th of February 2013. The documented observations were then compared immediately with patients' medication orders and recordings were made onto data collection sheets. Patients' medication was reviewed before each administration by the observer to enable interventions to be made to prevent potentially significant errors from getting to the patient. Recordings were made onto a predesigned and pre-validated data collection sheet (appendix 3.6). The study was preceded by a 2-day pilot study to test the usability and reliability of the tool. After the pilot study, a 2-week period was allowed to elapse before the actual study began though the observer visited the wards daily. This was to reduce the Hawthorne effect. Barker (2002a) found that though people being observed initially tend to be extra careful, they return to their normal self after sometime. In addition, the observer was also taught to observe discrete attitudes during the process as it also contributed to maintaining the observed subject's habitual pattern of work (Barker et al., 2002a, Barker et al., 2002b). Patients' demographic details and nurses' characteristics were also recorded on the collection sheet. When errors occurred, the observer clarified the error with the responsible nurse and possible causes were then recorded.

The administration errors were classified by two clinical pharmacists separately. The individual classifications were compared and any disagreements were resolved by consensus in a meeting. The classifications were based on previous works done on medication errors (Stubbs et al., 2003) which was modified by Chua and colleagues (2010). The errors were classified as Grade 1: Probably clinically significant; Grade 2: Potentially minimal significant; Grade 3: Potentially definitely significant; Grade 4: Potentially fatal.

3.2.3.4 Data Analysis

Data were entered into and analysed with SPSS (Statistical Package for Social Sciences) version 16 for Windows. Descriptive analysis was performed on all the data to obtain the frequency of occurrence of all types of drug administration errors, patient characteristics, nurse characteristics and clinical significance. Associations between various variables and the occurrence of errors were analysed with chi square (χ^2) through cross tabulation and Odd ratios (OR) were determined at a 95% confidence interval. Potential risk factors for error causation were analysed in univariable and multivariable analyses. Any $p<0.05$ was considered as statistically significant. All interviews were conducted by the same investigator, transcribed verbatim and coded into common themes. Content analysis was performed and results discussed using the Reason's (1995a, 1990c) system approach to safety management which recognises the latent failures inherent in medication administration processes. To protect the confidentiality of participants, audio recordings were immediately copied electronically onto a computer and passworded. Nurses interviewed were also represented by special codes.

3.2.4 Phase II: Potential Contributory Factors to MAEs

This second phase followed almost immediately after data collection of Phase I was done. In the Phase I study, nurses involved in MAE were asked to clarify and provide possible causes of those errors. The various possible causes provided by the nurses were then coded into 3 prevalent themes: individual, working environment, and organisational factors. These themes were reviewed and validated by a reviewer. Twelve of the nurses involved in these MAE were then invited for in depth face-to-face interviews. This number was chosen because studies have shown that 6-12 participants are enough to reach saturation for a particular professional group working in a particular setting (Guest and Bunce, 2006). These interviews were conducted in a private office of the study hospital during working hours. Participants were informed that the interviews were being recorded and verbal consent was taken to confirm written consent signed. The interview was guided by a semi-structured schedule (appendix 3.7), which was based on Reason's model of accident causality. It was designed to solicit views on causes of medication administration errors. It begun with asking participants what they consider were the causes of the errors they were involved in. They were then asked

to discuss specific error causation factors and how they perceived each could have contributed to error generation. They were asked to offer their practical experiences and also to consider what they had observed with colleagues whiles working at the department. Finally, they were asked to discuss any other issue they felt important to include. They were then asked to ask any questions they have about the study. All interviews were conducted by the same investigator, transcribed verbatim and coded into common themes. Content analysis was performed and results discussed using the Reason's (1995a, 1990c) system approach to safety management which recognises the latent failures inherent in medication administration processes.

3.3 Section Two: Survey of Hospital Pharmacists on Medication Safety Activities

3.3.1 Study Design

This part of the study involved a national survey of pharmacists working in hospitals by using self-administered questionnaire to describe hospital pharmacists' activities. Loewen et al (2010) used quantitative questionnaire to study the activities undertaken by hospital pharmacist and to characterize their work day and determine their perceptions of the impact of their activities. Another study was able to classify pharmacy services in a hospital by using questionnaires made up of quantifiable parameters (Tuffaha and Koopmans, 2012).

3.3.2 Study Setting

There were 505 pharmacists working in hospitals in the 10 regions of Ghana at the time of the study. There were three teaching hospitals, which provided tertiary care services and served as referral centres for the country. The country also has regional, district and municipal healthcare facilities. There were also polyclinics, which were mostly situated in urban areas to provide primary healthcare and other specialised services depending on the availability of resourced personnel and facilities. The distribution of pharmacists across the country was not uniform with more than 50% working in the three teaching hospitals.

3.3.3 Data Collection Tool

A concise, easy to complete questionnaire was required to achieve a good response rate. This is because majority of the data collection was to be done at a national pharmacy meeting. This demanded the use of many closed ended questions and few open ended questions. To provide discreet relevant hospital pharmacist activities for the questionnaire, a review of published literature for the period 1983 to 2013 was conducted in July 2013. Overview of studies is presented in appendix 3.8. The various activities that were reported contributed to making the data collection tool.

The 4- page questionnaire was piloted on 20 conveniently selected pharmacists at their offices. Time spent on each questionnaire and comments from participants were recorded. Majority of participants were asked to complete the questionnaires immediately and return to researcher. This was to mimic the proposed setting of the main study, which would require instant completion. Nineteen of the questionnaires were retrieved for analysis. The average time spent was 12minutes (min=9, max=17). Comments led to minor changes such as the deletion of participants' age that was not required for the study. Also certain activities were too similar to differentiate and had to be joined together. It was also advised that the information for consent be summarised and included on the front page of the questionnaire.

The final questionnaire (appendix 3.9) consisted of closed and open- ended questions. The first section was on participants' demographics. The name and age were excluded, as they were not required for the study objectives. This was also important to provide anonymity to participants. This section requested for the sex, name of working institution, region, level of care, highest current level of education, years since completion of pharmacy education, working experience in hospital practice and current hospital. The second section requested for the area of participant's specialty. It also requested for the main area of practice. The third section contained questions that sought the perception of participants on the involvement of pharmacists, doctors and nurses in medication safety in their institutions. Section four was a single question that requested respondents to grade their involvement in medication safety on a scale of 0 to 10. The fifth section asked respondents to rate on the scale of 0 to 7, their perceived impact of their roles on selected patient care outcomes: detection of adverse drug reactions, reporting of adverse drug reactions, reduction of hospital cost, reduction in mortality, reduction in morbidity, reduction in length of patient stay, increase confidence of patient and decrease hospital readmission. The next section contained a table of discreet

medication safety activities. Participants were to select those they were involved in and provide approximate average weekly time spent on each selected activity. The next section provided a list of factors that affected participants' involvement in selected activities and attitudes of other healthcare professionals. The next section asked about whether medication errors were detected, and if so how it was detected and reported by participants. Finally, there was an open-ended question soliciting for participants' views on how pharmacists could enhance their medication safety activities.

3.3.4 Data Collection

Purposive sampling technique was employed to ensure fair regional distribution of respondents. The questionnaire was administered at a national pharmacy meeting on 15th August 2013. After retrieving questionnaires from the national meeting, there was an initial analysis to determine the distribution of the questionnaires based on regional distribution of respondents compared with targeted population data. Areas with below 20% respondents' rate were noted and participants in those regions who did not attend the national meeting were identified to receive questionnaires at their offices. This took place from July to September 2013. At the national meeting, a brief introduction and purpose of the study was given by the investigator. Participants were then provided with participation information leaflets (appendix 3.10). Participants provided consent after they had read the leaflet before completing the questionnaires (appendix 3.10).

Where the questionnaires were administered during the pharmacy meeting, they were retrieved the same day. However the questionnaires that were administered in the offices of participants were followed up for collection on a later date that ranged from one to twelve days.

3.3.5 Data Analysis

Information on completed questionnaires were analysed using SPSS version 16 for descriptive statistics and inferential statistics. Chi square and One- way ANOVA tests were used to compare associations between variables and *p*-value less than 0.05 was termed statistically significant.

3.4 Section Three: Evaluation of Intervention Reports of Pharmacists

3.4.1 Study Design

The part of the study consisted of two phases. Phase I involved a retrospective evaluation of clinical intervention reports of hospital pharmacists who were engaged in direct patient care. This was almost immediately followed by Phase II, a key informant interviews with sampled pharmacists whose clinical intervention reports had been evaluated in Phase I of the study.

3.4.2 Study Setting

The study took place at the Pharmacy Department of Korle Bu Teaching hospital. Detailed description of the study hospital had been provided above. At the time of the study, the hospital had 87 pharmacists. The main pharmacy services provided in the hospital were dispensing, clinical services, drug information, research and small scale manufacturing. There were 28 pharmacists who actively undertake clinical duties across the various wards of the hospital. Pharmacists undertook clinical activities on the wards of the following departments: medicine, surgery, obstetrics and gynaecology, paediatric, emergency, plastics and reconstructive surgery and cardiothoracic centre. Pharmacists had discovered drug errors during their normal duties from review of patient medical records, laboratory reports, interactions with other health care professionals, patients, caregivers or family members. The intervention reports had been deposited at the registry of the Clinical Pharmacy Unit of the hospital.

3.4.3 Phase I

3.4.3.1 Evaluation of Clinical Interventions

To evaluate the clinical interventions of pharmacists working in the hospital, copies of intervention reports for the period January 2011-December 2013 were made and relevant data extracted with a specially designed extraction tool (Appendix 3.11). Pharmacists had previously identified drug errors and manually reported the clinical interventions made using a standardised clinical intervention reporting form (Appendix 3.12).

3.4.3.2 Data Analysis

The extracted clinical intervention data was entered into and analysed using SPSS version 16 for Windows. Descriptive analysis was performed on all the data to obtain the frequency of clinical interventions, drug characteristics and pharmacist characteristics. Aggregate data were tabulated and summarized using frequency statistics such as count, range, mean and standard deviation. Descriptive analyses of all drug error types and related interventions were also tabulated. Pharmacist Clinical intervention data were compared between drug classifications, drug error types and whether pharmacist interventions were accepted or not using Chi square test dichotomous variables and p-values less than 0.05 were considered statistically significant.

3.4.4 Phase II

3.4.4.1 Key Informant Interview

Interview techniques are useful in gaining rich insight into a subject matter. Researchers used interviews to explore the possible causes of different types of medication errors (Ross et al., 2012, Dean et al., 2002a, Taxis and Barber, 2003b, Beso et al., 2005). The interview process probes and provides detailed information as well as other useful information that the researcher had not considered prior to the start of a study. Authors have pointed to the utility of interview techniques in gaining rich information regarding patient safety incidents (Gawande et al., 2003, Silen-Lipponen et al., 2005). Interviews are then subjected to thematic content analysis. Braun and Clarke (2006) developed the five stages of content analysis which has been described in Figure 3.1 below:

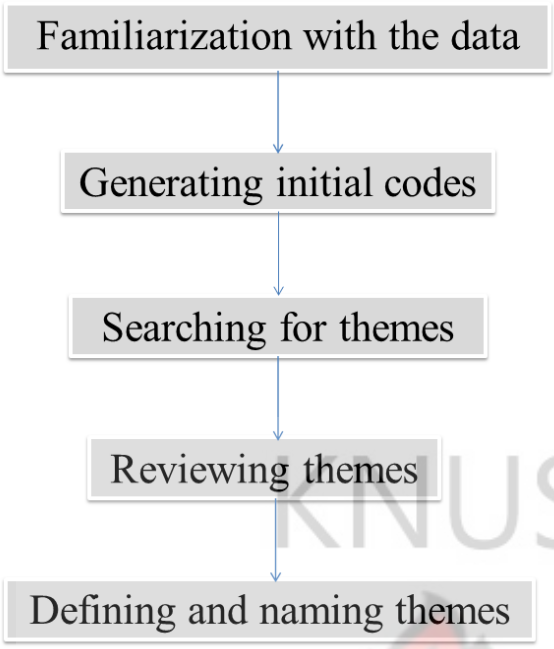


Figure 3.1: Stages of Thematic Content analysis of interviews recommended by Braun and Clarke adopted from 'Identifying the Latent Failures Underpinning Medication Administration Errors: An Exploratory Study' by Lawton et al.(2012)

3.4.4.2 Study Participants

In determining the eligible participants for the key informant interview, the outcome of the review of intervention reports was used. This first part of the study revealed that 24 pharmacists reported clinical interventions during the period January 2011 to December 2013. As at the time of the interview, 5 pharmacists were not available to be interviewed. Additionally, 2 pharmacists were no longer actively performing clinical duties. Seventeen pharmacists were finally declared eligible to participate in the study and they were all invited.

3.4.4.3 Study Design

This part employed qualitative, in-depth, face-to-face interviews of pharmacists who had submitted clinical intervention reports during the 3 year period. At the study hospital, not all pharmacists undertook clinical interventions. The data collection tool in the form of an interview guide was required for the interview.

3.4.4.4 Interview Schedule

A semi-structured interview schedule was designed. It was made of up four main parts: background, clinical intervention process, skills and training requirement and challenges encountered. The interview was then piloted on two senior pharmacists working in the study site. The interviews were recorded, transcribed and reviewed. The pilot study led to some minor changes intended to make the questions more open-ended so as to obtain more insights into the subject matter. The time spent interviewing a participant was between 25-35minutes. The final interview schedule is presented in Appendix 3.13.

3.4.4.5 Data Collection

Seventeen pharmacists were personally invited by the researcher to participate with an invitation letter (Appendix 3.14). In addition to the letter, information sheets (Appendix 3.15) and consent forms (Appendix 3.16) were added. Participants were asked to carefully read the participant information sheet before making a decision to take part in the study. They were then asked to complete two copies of the consent form and present one copy to the interviewer on the day of the interview. Researcher visited participants on a later date to agree with participants on place and date of interview. The interviews were conducted in the pharmacists' offices between 11th March and 8th April 2014. The interview lasted between 30-35 minutes. Interviews were recorded with an audio recorder with the permission of each participant. Interviews were then transcribed verbatim.

3.4.4.6 Data Analysis

The recorded interviews were transcribed verbatim. The transcripts of the interviews were coded to maintain confidentiality of interviewees and then subjected to content analysis to draw out common themes.

3.5 Section Four: Perceptions of Doctors and Nurses On Pharmacists' Roles

3.5.1 Study Design

This part of the study was a cross sectional descriptive study representing the experiences and expectations of doctors and nurses on the involvement of pharmacists in medication safety activities in KBTH.

3.5.2 Data Collection Tool

In ensuring the validity and reliability of the study tool, there was the need to undertake a pilot study. The objectives of the pilot study were the following: 1) to confirm the inter-rater agreement of respondents 2) to determine if enough doctors attend morning clinical meetings of the various departments and 3) to determine which clinical units of the selected hospital do not interact at all, by their nature, with pharmacists during their routine work schedules.

A questionnaire was designed and administered to 10 doctors and 10 nurses randomly selected. The same questionnaire was sent out twice to each of these participants, with an interval of 2weeks and their responses subjected to Cohen's inter-rater agreement analysis to determine validity and reliability of the questionnaires (Cohen, 1988). The kappa (κ) statistic for the answers given by the same person in response to the same question ranged from 0.755 to 0.960 with an average $\kappa=0.84$ (S.D±0.05) (see Appendix 3.17). The agreement of the tool's questions was classified excellent since κ was greater than 0.75 for all the questions (Fleiss et al., 1981).

During the pilot period, the investigator also visited morning meetings of the various departments and recorded attendance based on the different grades of doctors and nurses. This was to determine suitability of the meetings for administering the questionnaire. These records were then compared with the formal list of doctors and nurses registered with each department. The results showed that fairly all grades of doctors attend morning meetings and hence it was appropriate to administer questionnaires at the meeting to maximise participation. However, at some departments, only nursing heads occasionally attended the meetings. The wards were found to be more conducive than clinical morning meetings for administering questionnaires to nurses. Moreover during departmental visits, it was realised

that specialised units like maxillofacial nurses and surgeons rarely interacted with pharmacists.

The pilot study led to minor changes to the questionnaire, which were mainly rewording and adding more options to some of the questions.

3.5.3 Data Collection

Doctors in Korle Bu Teaching Hospital worked mainly from 8am till 4pm and some skeletal staff continued through the night whiles nurses worked on 3-shift bases: 8am-2pm, 2pm-8pm and 8pm-8am.

Data collection was done differently for doctors and nurses because of the outcome of the pilot study. For most of the doctors, data collection was done at a morning clinical departmental meetings by the same investigator. A brief script (Appendix 3.18) describing the purpose of the study and inviting participants was read by the researcher before each data collection at the meetings. A letter (Appendix 3.19) outlining the purpose, confidentiality of study participants responses and consent request was added to the questionnaire for doctors who receive questionnaires at their offices and all nurse-respondents.

Description of the questionnaire

A questionnaire (Appendix 3.20) consisting of mainly closed-ended questions with two open-ended questions was used to collect data. The questionnaire was divided into four sections: demographics, experiences with pharmacists, views on what the pharmacists' roles are and expectations of their role in medication safety. Most of the sections contained structured statements that required selection. The open-ended questions sought to explore additional views on ways to enhance pharmacists' future roles and also other reasons for interacting with pharmacists. For most of the closed-ended questions, the answers were to be given on either a four point Likert scale ranging from 'always' to 'not at all' or a five-point Likert scale ranging from 'strongly disagree' to strongly agree'.

Sampling

There are disagreements in literature about the appropriate sample size method to employ for Knowledge, attitude and practice studies. For this study, the precision method was deemed

appropriate. Studies on the *perceptions, experiences and expectations regarding pharmacists' role* employed prevalence between 10-50% (with sample size ranging from 96 to 332) (Gillespie et al., 2012, Kucukarslan et al., 2011, Tahaineh et al., 2009). Using a prevalence of 30% (p), with 5% precision (d) at 95% confidence interval, sample size (N) of 323 was obtained with the formula:

$$N = Z^2 \times p(1-p)/d^2$$

Hence self-administered questionnaires were administered to 320 conveniently sampled doctors and nurses. Questionnaires completed at the clinical meeting by doctors were sealed and collected the same day while uncompleted ones were collected at their offices at a later date. Nurses presented sealed completed questionnaires to the data collectors at their wards at a later date. The data was collected within September and November 2013.

Administrative verbal permission was obtained from Heads of Department/Unit where questionnaires were distributed.

3.5.4 Data Analysis

Data was analysed using the Statistical Package for Social Sciences version 16.0 for Windows (SPSS Inc., Chicago, Illinois) software. Data were described using frequency distribution. Items were subjected to factor analysis to generate groups. Chi-Square tests were used to compare responses and $p<0.05$ was considered statistically significant. In the presentation of results, strongly agree and agree were collapsed into an overall agree response, and strongly disagree and disagree were collapsed into an overall disagree response. The items listed under Questions 6 and 7 of the questionnaire (appendix 3.20), which expressed the perceptions of participants on the roles of pharmacists, were subjected to factor analysis to group the roles. Table 3.2 provides the sampling adequacy and sphericity test results. The sampling measure of 0.909 showed that the sample size was very adequate for the analysis. The sphericity test was also statistically significant ($p<0.001$).

Table 3.2: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.909
Bartlett's Test of Sphericity	Approx. Chi-Square	2.996E3
	df	210
	Sig.	0.000

Chapter 4

4 Results

Results for this study are divided into four sections. The first section presents results of medication administration errors. The second section presents the results of the national survey of pharmacists while that of the third section gives that of the reviewed documented clinical interventions of pharmacists. Finally, results for the perceptions of doctors and nurses about pharmacists' medication safety activities are presented in the fourth section.

4.1 Section One: Medication Administration Errors

4.1.1 Study Participants

There were 61 nurses at the ED of which 5 were administrators and were not directly involved in drug administration. Seven nurses were not available during the study period. The remaining 49 agreed to take part in the study (Table 4.1). During the scheduled observation periods, not all admitted patients were observed. Observations went on between 8am-10am, 3pm-5pm and 10pm-12am. Only patients who had spent 24hrs at the ED were eligible to be observed. All the nurses observed worked full time at the ED. Some nurses were observed more than others because they worked at different shifts and wards at different times. During the study, 1332 administrations to 338 patients were observed. Table 4.2 provides the profile of patients observed at the ED during the period.

Table 4.1: Characteristics of Nurses in the study (N=49)

Characteristics		Frequency (%)
Sex	Male	2(4.1)
	Female	47(95.9)
Age (year)	26-31	30(61.2)
	32-37	12(24.5)
	38-43	1(2.1)
	44-49	3(6.1)
	>50	3(6.1)
Years of experience, mean (S.D)	4.2 (±4.36)	
Months spent at the ED, mean (S.D)	31 (±21.39)	
Mean number of patients per nurse (S.D)	6 (±2.03)	
Number of assistants per shift (min-max)	2 (0-4)	

Table 4.2: Characteristics of patients admitted during the study period (N= 338)

Characteristics		Frequency (%)
Age (year)	<21	29 (8.6)
	21-40	95 (28.1)
	41-60	110 (32.5)
	>60	104 (30.8)
Sex	Male	149 (44.1)
	Female	189 (55.9)
Length of stay (days), mean (S.D)	3(±1.88)	
Number of drugs received at the time of observation, mean(S.D)	5(±2.05)	

4.1.2 Error Rate

Of the 1332 TOEs, at least one error was detected in 362 of them. This represents an error rate of 27.2%. However the error rate excluding lack of drug availability was 12.8%. When the Wrong time error was accounted for (error occurring 58 times), the error rate fell to 22.8%. The error rate for IV doses was 13.8%. The highest occurring error type was omission (n=281, 77.6%), wrong time (n=58, 16%) and wrong administration technique (n=8, 2.2%). Omission error due to unavailability of medicine was 48.9% (n=177) of the total errors. The other error types occurred rarely (Figure 4.1) and there was no drug deteriorated error.

4.1.2.1 Variables and Occurrence of Errors

The occurrence of error was significantly associated with parenteral use ($\chi2$=21.498;df=1;p<0.001), night shift ($\chi2$=0.378;df=1;p=0.029), number of patients under nurse's care ($\chi2$ =26.6; df=14; p=0.022) and patient age ($\chi2$ =0.013; df=72; p<0.001). However the occurrence of error was not significantly associated with length of patients' stay ($\chi2$ =16.8; df=11; p=0.114), nurses years of experience ($\chi2$ =71.9; df=14; p=0.059) and number of months nurse has spent in unit ($\chi2$ =68.4; df=15; p=0.181). The 2x2 contingency

table of variables and the occurrence of all error types and errors without drug unavailability error types is presented in Table 4.4.

4.1.3 Classification of Drugs Involved in MAEs

Drugs administered were classified using their generic names in accordance with the British National Formulary (BNF, 2012). The errors associated with each class are presented in Table 4.3. The drug with the highest errors were co-amoxiclav (n=31), ceftriaxone (n=24), enoxaparin (n=15), esomeprazole (n=14) and frusemide (n=14).

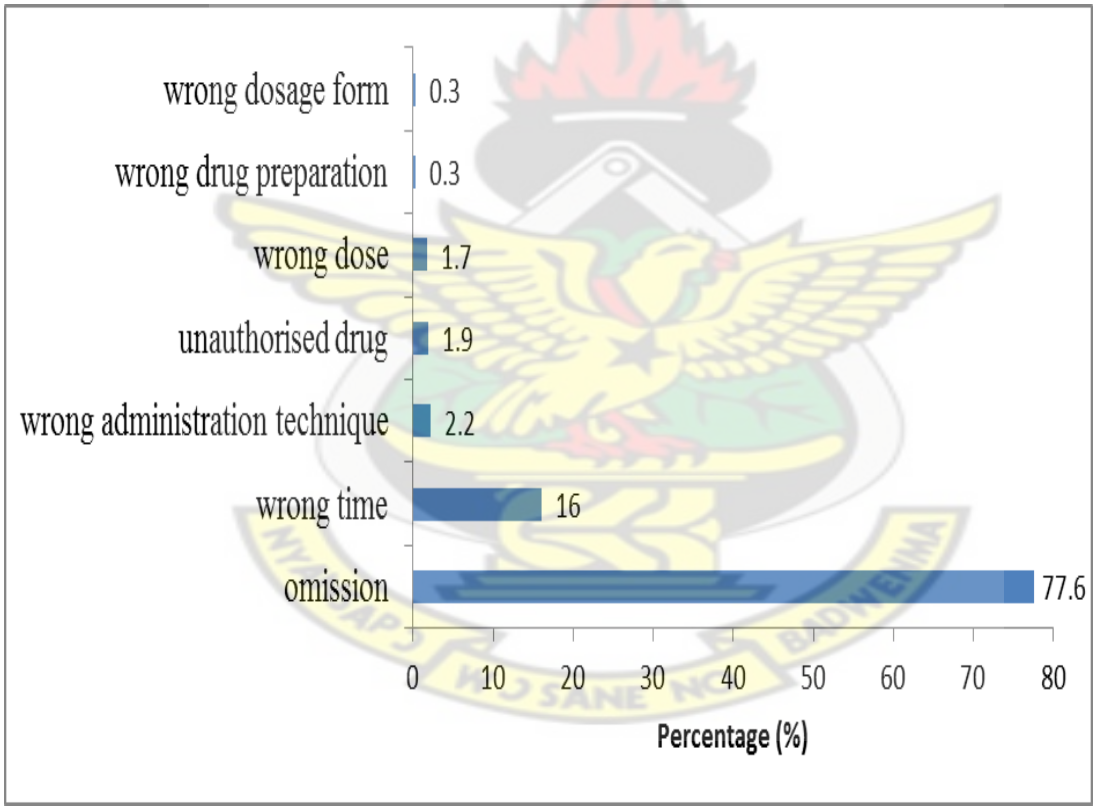


Figure 4.1: Percentage error rate of the types of MAE

Table 4.3: Drug classifications with their occurrence of errors

BNF* Class	**Number of TOE (% of total)**	**Number of TOE with errors (% within class)**	**Error Rate**
Gastrointestinal	94 (7.1)	29(30.9)	2.2
Cardiovascular	434(32.6)	108(24.9)	8.1
Respiratory	20(1.5)	9(45)	0.7
Central nervous system	170(12.8)	35(20.6)	2.6
Infections	439(33)	134(30.5)	10.1
Endocrine	61(4.6)	19(31.1)	1.4
Obstetrics, gynaecology and urinary-tract	2(0.2)	0(0)	0
Malignant disease & immunosuppression	1(0.1)	1(100)	0.1
Nutrition and blood	77(5.8)	17(22.1)	1.3
Musculoskeletal and joint	27(2)	7(65.9)	0.5
Eye	4(0.3)	3(75)	0.2
Others#	3(0.2)	0(0)	0
Total			

*BNF=British National Formulary

Others include products that do not fall into the above classification

There were no administrations of products belonging to such classification as ear, nose and oropharynx, skin, immunological products and vaccines and anaesthesia.

Table 4.4: Univariate Regression Analysis of Patients at risk of errors

Factor	Occurrence of Medication Administration Error (MAE)				MAEs without drug unavailability errors	
	Error (n)	No error (n)	OR (95% CI)	p-value	n	OR (95% CI)
Patient sex (Male)	165	423	1.08 (0.85-1.38)	0.280	76	0.98(0.645-1.488)
Drug class (cardiovascular)	108	326	0.84 (0.65-1.09)	0.107	57	0.67(0.426-1.059)
Drug class (infections)	134	305	1.28 (1.00-1.65)	0.032	51	1.65(1.063-2.549)
Dosage form (Parenteral)	184	357	1.78 (1.39-2.27)	0.000	70	1.86(1.221-2.834)
Nurses years of experience[#]						
6 -10	38	118	0.89(0.60-1.31)	0.094	22	0.61(0.308-1.212)
> 10	29	37	2.17(1.31-3.58)	0.020	11	1.38(1.228-3.016)
Nurses months in unit[*]						
13-24	88	438	0.68(0.49-0.94)	0.102	28	1.38(0.761-2.508)
> 24	168	458	0.80(0.60-1.06)	0.071	95	0.49(0.299-0.808)
Observation shift (night)	144	368	1.08(0.84-1.38)	0.029	69	0.86(0.563-1.317)

compared with less than 10 years of nursing experience

* compared with stay up to 12months

4.1.4 Clinical Severity of MAEs

The two clinical pharmacists classified 360 errors as potentially clinical significant (36.1%), minimally significant (36.9%) and definitely significant (26.7%), details presented in Figure 4.2. Only one of the errors was potentially fatal but this was intervened by the observer. Most of the definitely significant errors involved omission of antibiotics for severely ill patients.

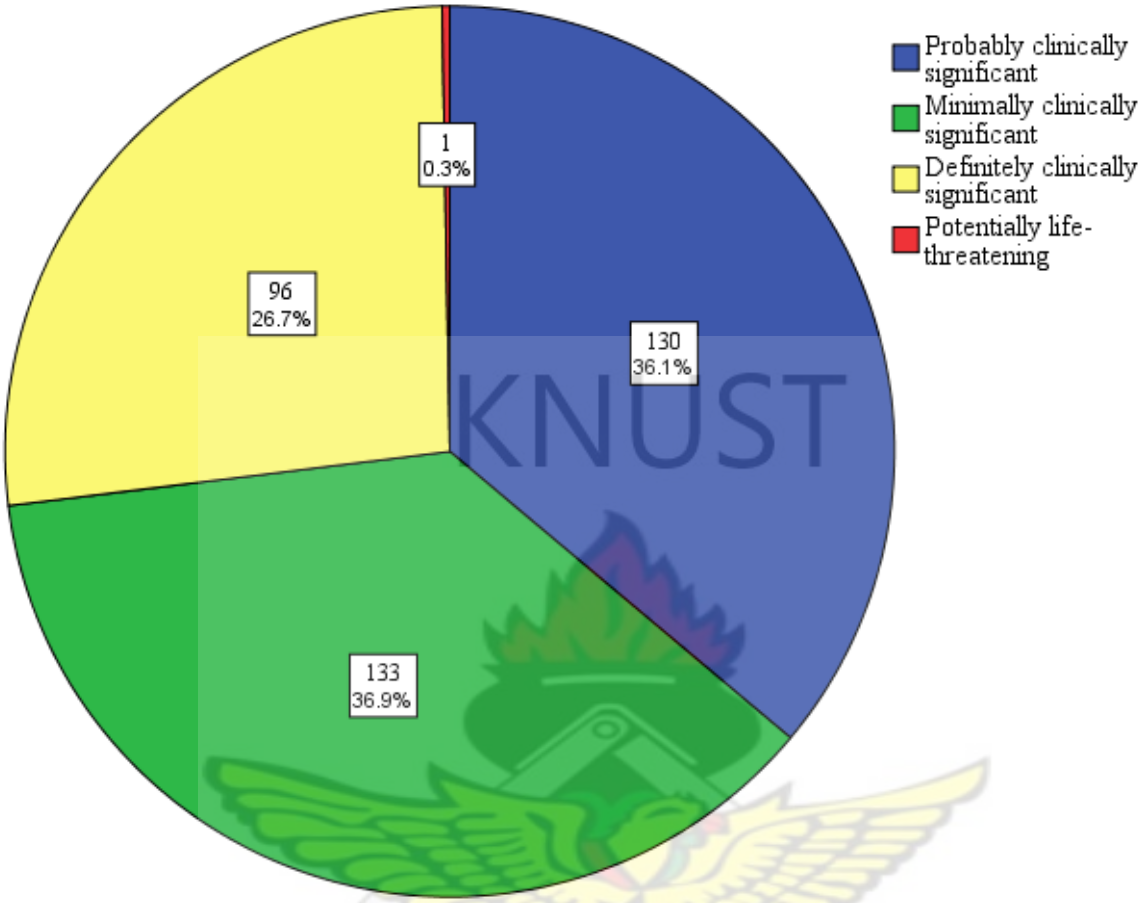


Figure 4.2: Clinical significance of MAEs

The error categories involved included omissions, unauthorised drug and wrong dosage forms administered, administering drugs using the wrong technique etc. Examples of specific scenarios are provided in Table 4.5.

Table 4.5: Some examples of observed MAEs

Error Category	Examples
Omission	Diabetic with Random Blood Sugar = 21mmol/L is to receive soluble insulin. Staff nurse chart as given but moves out of ward because ward felt stuffy and as an asthmatic, she felt very uncomfortable. On her return, she had forgotten. Patient's level had risen to 28mmol/L. [Definitely significant]
Unauthorised drug	Staff nurse reconstitute Co-amoxiclav and draws into syringe. She also does same for iv hydrocortisone into another syringe. She receives a call and looks pensive afterwards. She hands out syringes to colleague nurse to administer to a different bed number than intended. Colleague did not cross check from patient's chart. [Definitely significant]
Wrong time	Adult male is to receive iv cloxacillin, iv metronidazole, suppository paracetamol and iv enoxaparin. All morning doses are missed and the staff responds that patient had not eaten and that all iv medication should be given after meals. [Minimally significant]
Wrong drug preparation	Patient on NG tube is to receive oral amlodipine and metronidazole. Nurse wrap tablets in hospital sheet, crushes with empty vial and then pours into cup. Some powder is left on sheet, possible underdosage. [Minimally significant]
Wrong dose	A prescription of *40mmol of Potassium Chloride* once daily is for a 24year old. It is available as a 10mls amp of 1.34mmol/ml. Nurse draws all contents from 6amps (60mls) complaining that such calculation always confuses her. [Potentially fatal]
Wrong dosage form	A newly marketed oral haematinic which is available in ampoules was drawn into a 5cc syringe intended to be administered via parenteral route. [Definitely significant]
Drug deteriorated	Patient was rushed in fitting. In a rush, nurse administered an expired i.v diazepam which was part of expired drugs being assembled for the pharmacy. [Definitely significant]
Wrong administration technique.	Patient is prescribed iv aminophylline 250mg to be given by slow intravenous injection over 30mins. Nurse gives a small amount at a time. After the third time, she leaves to attend other patients. On her return, she administered the rest because patient was to receive all dose within 30mins.[Definitely significant]

4.1.5 Possible Causes of Errors

The study participants mentioned probable reasons for only 348 of the errors. However, the study participants could not attribute reasons for the rest of errors. The common identified ones with their number of hits are presented in Table 4.6.

Table 4.6: Possible causes for different types of errors (N=348)

Possible Reason	Error Type	Number of hits
Unavailability	Omission	177
	Wrong time	15
	Wrong drug	1
Staff factors (carelessness, forgetfulness, tiredness, oversight, lack of knowledge, lack of calculation skills)	Omission	26
	Wrong time	33
	Unauthorised drug	5
	Wrong dose	5
Workload	Omission	6
	Wrong time	22
	Wrong dose	1
Patient factors (like patient can't swallow, patient not eaten, drug already taken, refusal, unavailable at drug round, No I.V line)	Omission	27
	Wrong time	2
Prescription problem (wrong dose, illegibility, incompleteness, not written on chart)	Omission	12
Communication problem	Omission	9
	Unauthorised drug	1
	Wrong time	6

4.1.6 Interview with Nurses

At the time of the interviews, 10 nurses out of the 12 were available to be interviewed. The remaining 2 nurses were engaged in patient care and hence could not be interviewed. Each interview lasted between 19 and 40 minutes. Analysis of the data produced 5 main themes. Since the goal was to enhance understanding and generate hypotheses rather than achieve significance in a statistical sense, the findings are not presented numerically. Descriptions of

the themes using evidences from transcripts have been provided below. The themes and the number of counted excerpts from the interviews are provided in Table 4.7 and examples of nurses' statement on the contributing factors are in Table 4.8.

Table 4.7: Error provoking conditions

Major themes	**Error conditions**	**Number of excerpts**
Patient factors	Complexity of diagnosis Taking medicines on their own Language barrier Beliefs	14
Staff factors	Lateness Lack of knowledge Ill-health Careless Tiredness Routine Personal issues Conflicts Task	26
Work environment	Lack of equipment Overcrowding Distractions from relatives Lack of privacy Shift system	48
Team	Poor handing over Communication Power struggles	15
Organisation	Jobs Scheduling Hierarchical structure Reporting systems Poor supervision Medication supply Protocols and policies	8

Table 4.8: Excerpts of nurses' statements on error provoking factors

Patient	Taking medicines on their own	…you will get there, take the medicine wanting to give to the patient and the patient will tell you that I have swallowed it already…
	Complex nature of diagnosis	…if the person is a diabetic, if the person is hypertensive, the BP is not coming down, you can't sit you can't sleep, you are monitoring and the worse of this when you have esophageal varices cases, that one is worse because what you have to do, you always have to be with the patient, pump or ….
Staff	Routine	… because most of patients on the ward are on 1g and routinely that is what is given ...
	Lack of concentration	… We all have our problems at home, children at home, husbands, families and all that. Sometimes you are giving the drug but you are even absent minded…
	Lack of knowledge	…there is this anti-hypertensive drug that comes from the pharmacy as 5mg but the doctors write 2.5mg and it is enteric coated, and I didn't know that I shouldn't break it into two.
Work environment	Workload	…the system here is not too good. Ideally, we are magicians so you have to try your best to attend to all the cases you have … it will be so intense and so hectic here…
	Lack of equipment	…ideally some medications should be given by regulating the number of drops… eh syringe drivers and... infusion pumps and those things within a period of time. We don't have those equipment…

Table 4.8 (continued): Excerpts of nurses' statements on error provoking factors

Team	Power struggle	…and you think that because you are in green or blue belt or higher than that person, you could just instruct my subordinate without informing me.
	Handing over	Nurse who is supposed to come early to hand over to, does not show up, surely you will not do the usual detailed handing over that you have to…
Organisation	Supervision	… you are always on your own, no supervisor to discuss issues with…and even there are some nurses who become lazy because of this and they leave their work for students…
	Protocols and policies	..We don't have any protocol displayed. There is no protocol that says like … give it in this format, or that, we don't have any oral nor written policy that I can easily go and refer to, I just do what I can…

4.1.6.1 Description of the Themes

Work Environment

This was defined as the overall atmosphere of the ED. This is predominantly determined by the multidisciplinary-shared assumptions, the rules and norms that have evolved over time and which have forced individuals and teams to adapt to their environment. It also consists of the physical infrastructure and equipment that aid nurses in their work. Senior nurses and session heads drove the ward atmosphere. Interviewees mentioned that the ED was frequently overcrowded and some patients with severe conditions were made to sit on chairs. This they said affected drug administration. It was also mentioned that overcrowding led to overload. An interviewer mentioned that sometimes, she forgot particular patients because there were

too many patients under their care. She retorted 'I just lost sight of the patient'. Some interviewees even complained of the poor lighting systems, the physical ward arrangement ('*Some patients are kept at top floors which is not easily accessible'*) and the lack of basic equipment like mortar and pestle. Interviewees claimed that interruptions to safety critical tasks were common on the wards because relatives were allowed in the wards at all times. Moreover, interruptions appeared to have become accepted practice over time and they suggested that it was the 'cultural' norm. Those nurses who emphasized that interruptions were frequent also saw them as constant source of errors.

Staff factors

This describes the personal attitudes and characteristics of nurses. Interviewees mentioned that sometimes they just did not know what to do. They referred to the inadequate clinical knowledge as a potential error provoking factor. A particular problematic area was pharmaceutical calculations. They believed that their basic nursing education was not adequate to deal with those issues and had to rely on senior colleagues or other professionals. Some also suggested that nurses who perceived their role as 'just a job' and 'doing my shift' may be less committed to the role of caring for patients and making efforts to reduce errors they commit. Several nurses described the potential for family issues to affect their concentrations at work and hence results in more errors during the drug administration processes.

Patient factors

This related to the conditions that patients are admitted for, their beliefs, economic status, relatives/family members etc. interviewees mentioned that the lack of cooperation of patients can result in unavoidable errors like dose omissions. Some nurses interviewed said that some relatives had administered drugs to their patients at their blind sides. Some had also carried their previous medicines to the wards with the belief that they needed them.

Team factors

Nurses described their inter-personal relationships among colleagues and other healthcare professionals and intimated that they could affect the way they worked. They referred to the relationship between nurses as being a particularly important predictor of medication administration errors. Some expressed the power struggles which resulted in conflicts. Some

nurses said that if they needed to seek help from colleague she has had conflict with, they would rather wait. Senior nurses suggested that junior nurses were not taken seriously and this they felt led to apathy. Junior nurses felt that they could not challenge potential mistakes. On the other hand, some senior nurses mentioned that they were also being overburdened. They described the situation where all queries were routed through the senior nurse, regardless of the nature of the problem. An interviewee retorted *'I could even be in the middle of administering drugs to a patient and I have to stop to show a nurse what to do'*. Some senior nurses mentioned that while the role of ward coordination was part of their responsibilities, they were unable to fulfil it effectively because of staff shortages. According to the interviewees, there were some interruptions from doctors and patients during drug preparation and administration rounds. They got distracted and sometimes forgot totally what they were doing.

Organisation

Many nurses interviewed suggested that reporting climate was absent at the ED though they held the view that, it was vital for understanding why errors occurred repeatedly and for targeting appropriate interventions to prevent them. In addition, interviewees mentioned that there were no clear guidelines, protocols and policies on a lot more processes. They particularly mentioned the lack of protocols for handing over between shifts. Some said they have had to rely most of the time on their judgement and these have led to some errors. They suggested that these sometimes led to disparity in planning essential patient care activities to achieve a particular goal. They said there would be lack of role insight and direction. Some nurses mentioned that without clear-cut guidelines, some nurses leave their drug administrations, which are close to preceding shifts. They want to start their respective shifts from 'fresh start'. Other nurses also referred to the lack of adequate supervision. Interviewees mentioned that junior staff were sometimes allowed to work alone on a shift, especially night and weekend shifts.

4.2 Section Two: Survey of Hospital Pharmacists

A total of 182 responses were received. Six of the received responses were almost blank; 5 had only demographic details completed and 1 were not filled at all. As a result, a total of 176 (88%) completed questionnaires were analysed. The majority (38.5%) of respondents worked

in tertiary hospitals. This was followed by district hospitals (31.6%), municipal hospital (12.6%), regional hospital (8%), polyclinic (6.9%) and private hospitals (2.3%). Respondents' demographic characteristics are presented in Table 4.9.

Table 4.9: Characteristics of the respondents (n=176) and the target population (n=485)

Characteristics	**Respondents (n=176)**		***Target population (n=485)**	
	n	%	n	Percentage (%) of respondents to target population
Gender				
Female	69	40.1		
Male	103	59.9		
Total	172**	100		
Geographical location (region) of workplace				
Northern	12	7.1	58	20.7
Upper East	2	1.2	16	12.5
Upper West	4	2.4	14	28.6
Brong Ahafo	7	4.1	26	26.9
Ashanti	43	25.4	116	37.1
Volta	10	5.9	21	47.8
Eastern	17	10.1	31	54.8
Western	9	5.3	35	25.7
Central	5	3.0	18	27.8
Greater Accra	60	35.5	150	40.0
Total	169**	100	485	34.8
Highest level of education				
Master's Degree	46	26.29		
Postgraduate Diploma	2	1.14		
Bachelor's Degree	127	72.57		
Total	175**	100		
Number of years since completing pharmacy school				
0-4	53	30.81		
5-9	53	30.81		
10-14	31	18.02		
15-19	21	12.21		
≥ 20	14	8.14		
Total	172**	100		

* Number of hospital pharmacists from unpublished material of Ministry of Health (2011)

** Exclude missing data

4.2.1 Medication Safety Activities and Perceived Impact on Patient Care

Table 4.10 describes the medication safety activities that pharmacists indicated they were involved in, in their hospitals and the mean weekly time spent on each activity.

Table 4.10: Activities that Pharmacists routinely engage in and the average weekly time spent on them

Activity	**Number of respondents, n (%)**	**Mean time (Hours/week)(±SD)**
Interacting with the health care team, n=170	150(88.2)	13.7(16.5)
Counselling out- patients, n=170	156(91.8)	19.8(18.0)
Counselling in- patients, n=170	106(62.4)	11.9(16.4)
Providing patient discharge counselling and follow-up, n=169	65(38.5)	12.1(18.3)
Reconciling medications, n=169	117(69.2)	14.9(18.3)
Interviewing patients, n=170	112(65.9)	15.3(18.9)
Medication profile and medical record review, n=170	96(56.6)	15.4(20.0)
Presentation of drug regimen recommendations to care team or physician, n=170	109(64.1)	9.4(15.2)
Participating on rounds with inpatient care team, n=170	91(53.5)	9.7(9.4)
Drug monitoring and recommendation follow-up, n=170	93(54.7)	10.7(11.0)
Reconstitution of IV medication, n=168	36(21.4)	9.0(11.7)
Drug therapy dosing or management, n=169	108(63.9)	13.6(16.8)
Documentation of clinical interventions or recommendations, n=170	107(62.9)	12.1(16.0)

Table 4.10 (continued): Activities that Pharmacists routinely engage in and the average weekly time spent on them

Activity	Number of respondents, n (%)	Mean time (Hours/week)(±SD)
Follow-up after discharge, n=168	20(11.9)	7.5(11.4)
Formulation of drug protocols, n=170	69(40.6)	8.2(11.8)
Initiation of therapy, n=169	61(36.1)	10.1(15.2)
Discontinuation of therapy, n=169	59(34.9)	5.6(10.0)
IV to PO conversion, n=169	43(25.4)	9.8(12.8)
Training of students and interns, n=170	123(72.4)	14.4(13.6)
Monitoring of side effects, n=170	98(57.6)	14.2(16.1)
Reporting of medication errors, n=170	119(70.0)	11.1(15.1)
Laboratory reviews, n=168	49(29.2)	6.5(9.0)
Writing of prescriptions, n=169	53(31.4)	11.0(10.8)
Compounding of drugs, n=169	55(32.5)	10.7(15.2)
Responding to drug information questions, n=170	138(81.2)	12.0(16.8)

The most performed activity was counselling out-patients (91.8%) whiles the least was following patients up after discharge (11.9%). The mean weekly time spent on the activities ranged from 6.5 to 19.8 hours. Participants who had clinical pharmacy related additional qualifications (χ^2=37.749; p=0.049) and worked in tertiary care hospitals (χ^2=26.6; p=0.037) undertook more medication safety activities than those without. Moreover participants from tertiary care hospitals were more likely than others to undertake the following activities:

laboratory review odds ratio OR=1.613; 95% CI (1.813-3.201), Reporting of medication errors OR=1.188; 95% CI (1.006-2.353), Monitoring of side effects OR=1.159; 95% CI (1.061-2.179), Drug therapy dosing and management OR=1.116; 95% CI (1.158-2.144), participation on ward rounds with inpatient care team OR=1.075; 95% CI (1.057-2.009) , medication profile and medical record review OR=1.909; 95% CI(1.003-3.632), and counselling in-patients OR=1.613; 95% CI (1.083-3.110).

Almost all pharmacists (97.7%) believed that they were involved in medication safety activities in their daily routine. Respondents intimated that medication safety was also the shared responsibility of physicians (59.7%) and nurses (47.2%). Respondents' mean score of the perception of pharmacists' involvement in such activities on a 0 to 10 scale was 7.53 (SD=±1.568).

Respondents rated increase confidence of patient in medication use as their highest perceived impact of their medication safety activities (score=5.94). The overall score of the impact of the various services had a mean score of more than 5.0, (Table 4.11).

Table 4.11: Pharmacists' perception of the impact of their care they provide

Type of impact	Mean Score (± S.D)
Detection of adverse drug reactions	5.65 (1.525)
Reporting of adverse drug reactions	5.37 (1.770)
Reduction of hospital cost	5.65 (1.545)
Reduction in mortality	5.61 (1.463)
Reduction in morbidity	5.71 (1.311)
Reduction in length of patient stay	5.04 (1.849)
Increase confidence of patient	5.94 (1.338)
Decrease hospital readmission	5.27 (1.624)

Perceived impact (0=low impact, 7=high impact)

4.2.2 Error Detection Methods of Pharmacists

Most participants (90.9%) stated that they detected and reported medication errors in their hospitals. However, 69.3% documented interventions made on medication errors. The various ways of documentation were mainly using incident forms (42.6%), personal diary and notebook (27.3%), writing in patient medical records (18.8%), and others (9.1%).

4.2.3 Challenges Encountered by Pharmacists

Figure 4.3 describes the challenges faced by respondents in undertaking medication safety activities. The cited challenges included inadequate time (62.7%), spending most time in managerial activities (47.3%), lack of formal structures of engagement (43.8%), lack of motivation by superiors (34.9%), and no formal schedule by supervisor (32%). Only 7.7% stated that they lacked interest in those activities.

The perceptions of participants on the attitudes of healthcare professionals towards their medication safety roles in the hospital are summarised in Table 4.10. About 80% perceived colleague pharmacists, 50% perceived physicians and 47.4% perceived nurses to have very positive attitudes.

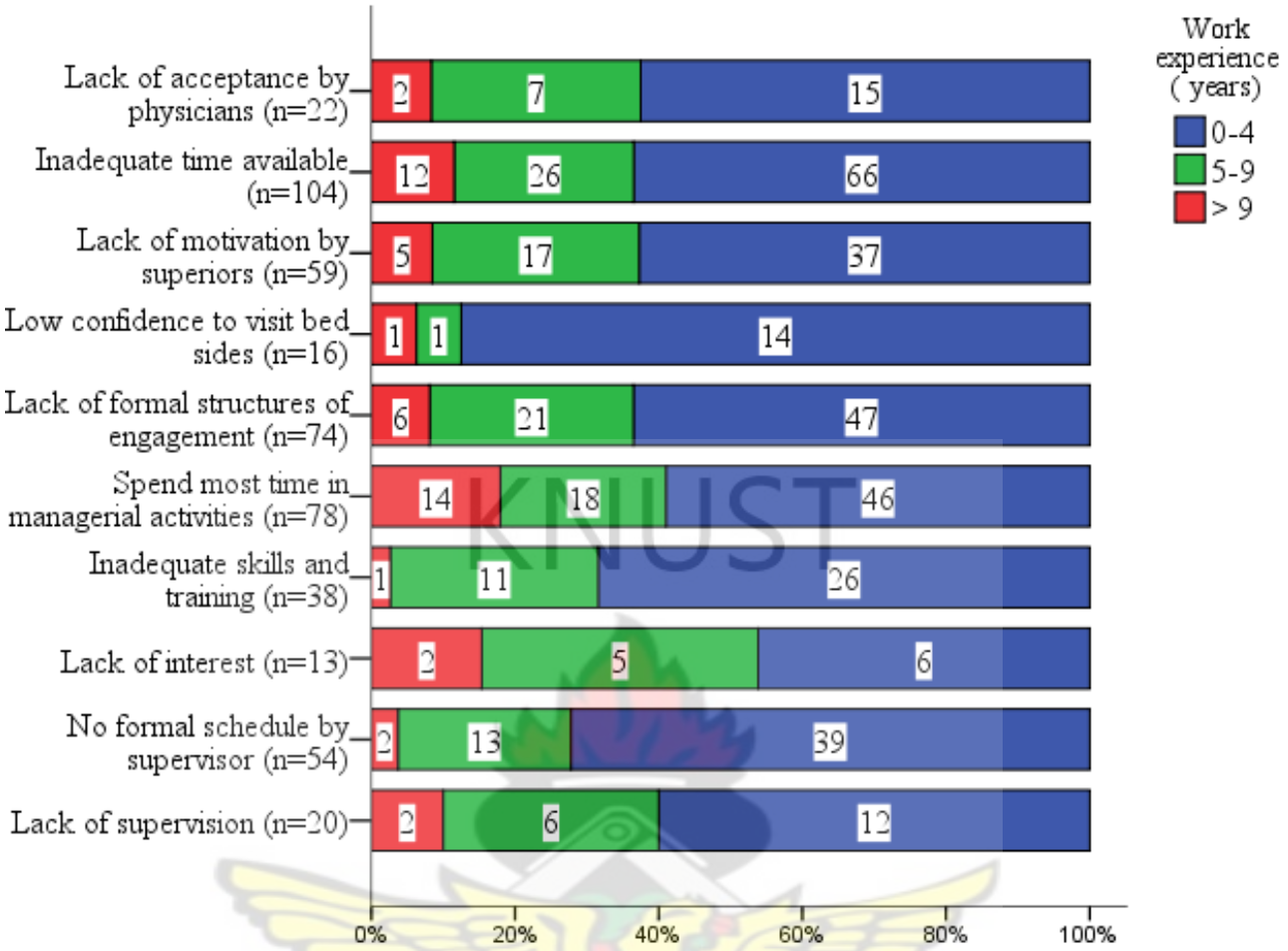


Figure 4.3: Respondents' challenges in engaging in medication safety activities

Table 4.12: Perceived attitude of health care staff towards pharmacists' roles

	Very positive n (%)	Somewhat positive n (%)	Neutral n (%)	Somewhat negative n (%)	Very negative n (%)
Physicians	78(50.0)	62(39.7)	11(7.1)	5(3.2)	0(0)
Nurses	74(47.4)	52(33.3)	27(17.3)	2(1.3)	1(0.6)
Colleague Pharmacists	124(80.5)	24(15.6)	5(3.2)	1(0.6)	0(0)
Other pharmacy staff	86(56.6)	42(27.6)	19(12.5)	4(2.6)	1(0.7)

4.2.4 Strategies to Enhance Safety

The most frequently mentioned strategies adopted by pharmacists to enhance their medication safety roles related to clinical pharmacy training, standardization of interventions reporting procedures and staffing. Excerpts are shown in Table 4.13.

Table 4.13: Respondents' recommendations on ways to enhance pharmacists' roles in medication safety activities

Theme	Examples
Clinical pharmacy training	Pharmacists should engage in more continuous professional developments to enhance their knowledge so more interventions can be made
	Pharmacists need to be sensitized and workshop organized routinely for them on medication safety
	…by enhancing clinical pharmacy training programmes to retrain pharmacists in new methods of medication safety….
	….there should be training and standardization on how documentation into patients' folder is followed…especially clinical interventions…
Standardization of interventions reporting	Standardized approach which is accepted by all health professionals and specific to pharmacist such that they will be held responsible for short falls
	Introduce a standardized pharmacist's intervention form to be part of the patient's medical record to be initiated by pharmacy unit, MOH/GHS.
	There should be a clearly defined and structured policy in the hospital which formally embraces the role of the pharmacist in the healthcare team.
	There should be a standard reporting form for all hospital pharmacists to make comparisons easier.
Staffing	Considering the non-availability of time and the busy work schedule for us, pharmacists, medication safety can really be enhanced if pharmacists get enough time. Others do some things, and others can do safety work….
	….more pharmacists with good work schedule should be available to take charge. Adequate staffing with right skill mix to enable pharmacists to do more…
	…. having only one pharmacist in a whole hospital is inadequate.
	….by employing more of pharmacists and training them and making a schedule for checking on medication safety.

4.3 Section Three A: Documented Clinical Intervention Reports

4.3.1 Study Participants

The evaluation revealed that 24 pharmacists made 529 paper-based reports over the 3 years. Majority of them were female (70.8%) and more than half had less than 10 years' experience (53.3%). The basic characteristics of pharmacists who made the reports are presented in Table 4.14.

Table 4.14: Characteristics of pharmacists involved in reporting (N=24)

Characteristic	Number	%
Sex		
Male	7	29.20
Female	17	70.80
Experience in practice (years)		
0-5	6	25.00
6-10	8	33.33
11-15	3	12.50
16-20	5	20.83
>20	2	8.33
Education & training		
MSc in clinical pharmacy	8	33.33
MSc Clinical Pharmacy (student)	3	12.50
Bachelor in Pharmacy	13	54.17

4.3.2 Drug Error Reports

Of the 529 paper-based drug error reports, 448 contained complete information and hence were included in the study. Reasons for not including the 79 were no drug name (n=67), no reason for error (n=6) and no recommendation (n=6). Drug errors were reported from all the units of the hospital that pharmacists worked; surgery (24%), medicine (22%), paediatric (21%), obstetrics and gynaecology (17%) and others (16%). Pharmacists discovered drug errors from review of patient medical records (74%), from other health care professionals

(10%), laboratory reports (8%), patients (6%), caregivers (1%), and other unspecified sources (3%). The frequently occurring therapeutic drug categories with errors were cardiovascular (44.4%), infections (22.8%), nutrition (12.9%) and musculoskeletal (6.6%). Table 4.15 describes the therapeutic drug categories and the degree of acceptance. The five most frequently reported classes of drugs associated with drug errors were antibiotics (20.2%), anticoagulants (19.9), iron supplement (16.3%), diuretics (9.4%) and non-steroidal anti-inflammatory drugs (4.4%). The most frequently reported drugs with error were warfarin (9.5%), potassium chloride (6.0%) and potassium citrate (5.5%). The drug error types identified were categorised as prescribing, dispensing/implementing, administering/patient receiving and monitoring (Table 4.16). Majority of reported drug errors were due to prescribing (70.9%) and least due to dispensing/implementing (2.0%). The most frequently reported drugs associated with prescribing errors included cardiovascular (42.6%), anti-infectives (22.9%), and nutritional agents (10.5%). During dispensing or implementation, the frequently reported drug errors were anti-infectives (50.0%), endocrine (35.0%) and cardiovascular (15.0%). The most frequently reported drug category associated with administration or patient receiving included anti-infectives (45.5%), cardiovascular (22.7%) and central nervous system (15.2%).

The common reasons pharmacists provided for drug errors included untreated indication (18.9%), wrong dose prescribed (12.5%), wrong drug prescribed (11.4%), medicine interactions (10.7%) and duplication of therapy (9.8%).

4.3.3 Clinical Interventions

The 20 drugs most frequently occurring in intervention reports are presented in Table 4.17. The pharmacists made 1019 interventions and recommendations in 448 handwritten reports. The average intervention per report was 2.5, standard deviation (±0.67), range (2-4), and mode (2).

The interventions and recommendations made have been categorised as drug regimen change (76.1%), monitoring required (13.0%), communication (5.4%), counselling required (5.0%) and adverse drug reporting (0.6%). The intervention types have been summarised in Table 4.16. Monitoring-required based interventions were significantly more likely to be accepted (130 vs 38; $p < 0.0001$). Drugs involving drug regimen adjustment by pharmacists included

potassium citrate (n=56), enoxaparin (n=54), warfarin (n=42), diclofenac (n=40), and morphine (n=37). Monitoring required interventions were made for potassium chloride (n=46), frusemide (n=22), warfarin (n=20), gentamicin (n=19) and metolazone (n=14). Drugs requiring counselling included warfarin (n=44), iron supplement (n=12), inhaled steroid (n=6), insulin (n=4), and lamivudine (n=3). Drugs involving communication between pharmacist and other healthcare professionals included frusemide (n=31), diclofenac (n=18), iron supplement (n=16), warfarin (n=11) and antacid (n=7).

Majority (90.5%) of the recommendations and interventions made by pharmacists were accepted by prescribers and other healthcare professionals. The degree of acceptance to the different types of interventions is shown in Figure 4.4. These interventions were communicated via the following means: verbal (76.4%), record in patient medical notes (16.3%), acted upon by reporting pharmacist (6.1%), prepare formal note (0.7%) and prescribe/procure for patient (0.5%) (Table 4.18).

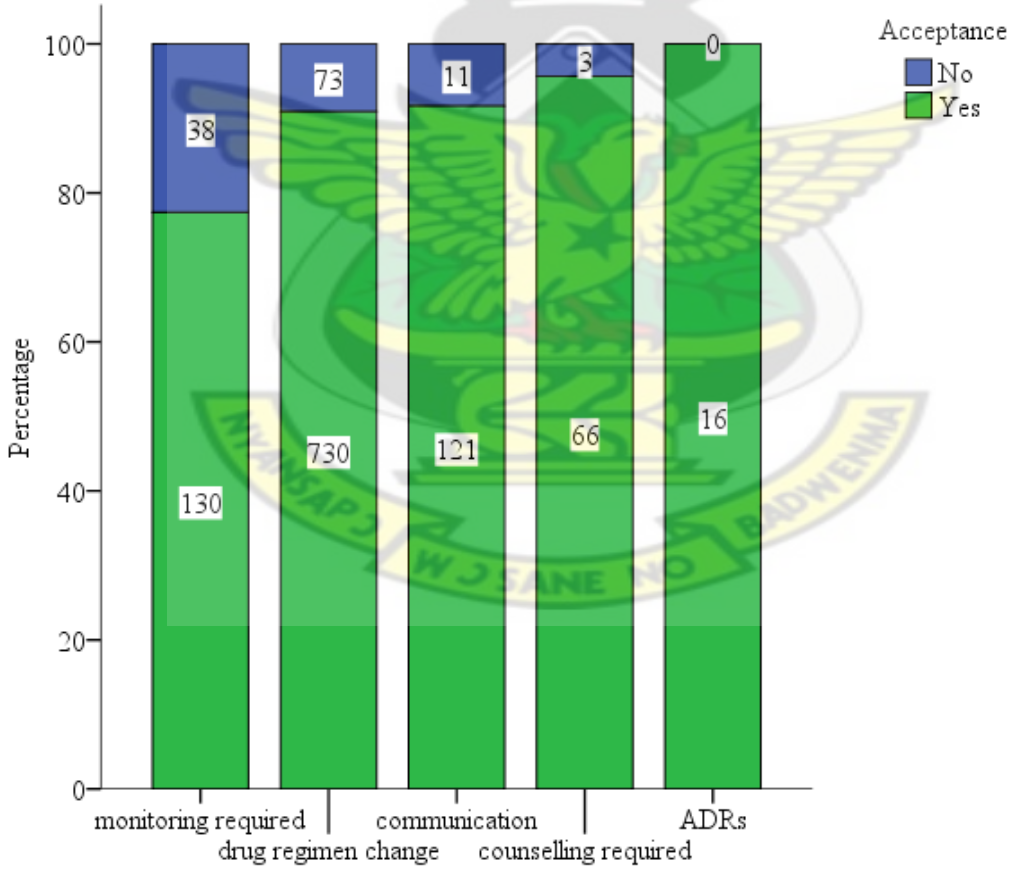


Figure 4.4: Degree of acceptance of clinical interventions

Table 4.15: Therapeutic category of drugs with intervention reports

Drug Category	Indication	Number of recommended interventions		p-value
		Accepted	Not accepted	
Cardiovascular (n=451[44.3%])	Anticoagulant	181	22	0.053
	Diuretic	87	9	<0.001
	Calcium channel blockers	16	8	<0.001
	Beta blockers	20	2	0.037
	ACE inhibitors	14	2	0.003
	Statin	17	3	<0.001
	Antiplatelet	15	1	0.001
	Nitrates	4	0	0.061
	Angiotensin receptor blockers	3	0	<0.001
	Others	41	6	0.004
Infections (n=231[22.7%])	Antibiotics	180	18	0.019
	Antimalarials	26	0	0.009
	Antivirals	5	0	0.101
	Antifungal	2	0	0.023
Nutrition (129 [12.7%])	Iron supplement	106	13	0.037
	others	10	0	<0.001

Table 4.15 (continued): Therapeutic category of drugs with intervention reports

Drug category	Indication	Number of recommended interventions		p-value
		Accepted	Not accepted	
Musculoskeletal (70 [6.9%])	NSAIDS	52	3	0.010
	Systemic Corticosteroids	11	0	<0.001
	Others	4	0	<0.001
Central Nervous System (51[5%])	Opiod analgesic	39	3	<0.001
	Sedatives	6	0	<0.001
	Antiepileptic	2	1	0.122
Gastro-Intestinal (50 [4.9%])	Proton pump inhibitor	27	3	0.027
	Antacid	7	0	0.980
	Laxative	5	0	0.001
	Others	6	2	0.001
Endocrine(14 [1.4%])	Oral antidiabetics	9	1	0.076
	Insulin	4	0	0.001
Respiratory(11 [1.1%])	Inhalational steroids	10	0	0.530
	antihistamine	1	0	0.890
Others (12 [1.2%])		12	0	<0.001

Table 4.15 (continued): Therapeutic category of drugs with intervention reports

Drug category	Indication	Number of recommended interventions		p-value
		Accepted	Not accepted	
Central Nervous System (51[5%])	Opiod analgesic	39	3	<0.001
	Sedatives	6	0	<0.001
	Antiepileptic	2	1	0.122
Gastro-Intestinal (50 [4.9%])	Proton pump inhibitor	27	3	0.027
	Antacid	7	0	0.980
	Laxative	5	0	0.001
	Others	6	2	0.001
Endocrine(14 [1.4%])	Oral antidiabetics	9	1	0.076
	Insulin	4	0	0.001
Respiratory(11 [1.1%])	Inhalational steroids	10	0	0.530
	antihistamine	1	0	0.890
Others (12 [1.2%])		12	0	<0.001
Musculoskeletal (70 [6.9%])	NSAIDS	52	3	0.010
	Systemic Corticosteroids	11	0	<0.001
	Others	4	0	<0.001

Table 4.16: Drug error types and reasons

Error type	Reasons	Number
Prescribing (n=721)	Untreated indications	174
	Wrong dose prescribed	127
	Wrong drug prescribed	116
	Medicine interactions	93
	Duplication of therapy	84
	Contraindications	78
	Side effects	50
	Failure to stop order	44
	Omitted laboratory test	18
	others	15
Dispensing/implementing (n=20)	Wrong drug dispensed	14
	Wrong label	5
	others	1
Administering/patient receiving (n=66)	Unavailability of drug	19
	Wrong dose administered	16
	Duplication	16
	Failure to discontinue	7
	Others	4
	Wrong drug administered	3
	Wrong dosage form	1
Monitoring (n=212)	Laboratory test omitted	91
	Blood glucose not monitored	77
	Side effects not monitored	40
	Others	19
	Medicine-disease interactions not monitored	16
	Culture and sensitivity omitted	14
	BP not checked	11

Table 4.17: Drugs most frequently occurring in intervention reports and their potential risk

Drug	Number in reports, n (%)	Examples of Potential risk	Outcome of intervention	
			Accepted	Not accepted
Warfarin	97(9.5)	Bleeding	89	8
Slow K	61(6.0)	Electrolyte imbalance	56	5
Gentamicin	60(5.9)	Tinnitus	45	15
Potassium Citrate	56(5.5)	Electrolyte imbalance	41	15
Enoxaparin	55(5.4)	DVT	46	9
Diclofenac	43(4.2)	Gastrointestinal bleeding	40	3
Heparin	39(3.8)	Bleeding	34	5
Morphine	38(3.7)	Respiratory depression	35	3
Frusemide	37(3.6)	Electrolyte imbalance	29	8
Iron Supplement	37(3.6)	anaemia	34	3
Clindamycin	27(2.6)	diarrhoea	25	2
Metolazone	26(2.6)	Electrolyte imbalance	26	0
Omeprazole	24(2.4)	Gastrointestinal bleeding	21	3
Atenolol	20(2)	Heart block	19	1
Hydrochlorthiazide	18(1.8)	Electrolyte imbalance	18	0
Metronidazole	16(1.6)	Increased hospital cost	14	2
Rosuvastatin	15(1.5)	Cardiovascular event	15	0
Cefuroxime	13(1.3)	Severe diarrhoea	13	0
Ciprofloxacin	13(1.3)	Muscle weakness	13	0
Lisinopril	13(1.3)	Neonatal mortality	11	2

Table 4.18: Types of Pharmacist Clinical Interventions

Intervention type	Method	Number of reports
Drug regimen change (n=775[76.1%])	Verbal	643
	Write in medical notes	109
	Acted on by pharmacist	20
	Prescribe/procure for patient	3
Monitoring required (n=132 [13%])	Verbal	82
	Write in patient medical notes	49
	Write formal note	1
Counselling required (n=52 [5.1%])	Verbal	9
	Acted on by pharmacist	42
	Prescribe/procure for patient	1
Communication (n=54[5.3%])	Verbal	45
	Write in medical notes	8
	Prescribe/procure for patient	1
Adverse drug reporting (n=6 [0.6%])	Write formal note	6

4.4 Section Three B: Interview with Pharmacists

A total of 17 pharmacists were invited to participate. Out of this, 12 pharmacists (70.6%) agreed to participate and completed consent forms. The characteristics of the interviewees are summarised in Table 4.19. The interviewees had varying degree of experience, in terms of years of practice and professional grade. Interviewees who had spent less than 5 years in practice submitted slightly higher intervention reports. Major categories were identified from interviewees' response to question which focused on how participants thought through the processes and experiences in undertaking interventions.

Table 4.19: Characteristics of interviewees (n=12)

Item	Number (n=12)	Number of reports submitted (n=448)
Years of practice		
<5	5	227
5-10	2	69
>10	5	152
Grade of pharmacist		
Pharmacist	4	198
Senior Pharmacist	3	98
Principal Pharmacist	3	71
Specialist Pharmacist	2	81

4.4.1 Identified Themes

The analysis of the transcripts yielded 7 major common themes. Since the goal was to enhance understanding and generate hypotheses rather than achieve significance in a statistical sense, the findings are not presented numerically (Butler et al., 1998). The primary aim of the study was to understand the intervention process and identify the potential barriers. Details of the process and the barriers have been provided with evidence from the transcripts. Five other themes were identified and defined during this work and are described with excerpts in Table 4.20.

Table 4.20: Common themes and excerpts from transcripts pharmacists

Theme	Number of hits	Excerpts
Pharmacists performed different types of medication related interventions	21	"These interventions include drug-drug interactions, overdose of drugs, under dosing, right frequency and the right dosage form for a particular patient. You want to be sure that the medication is the right medication for the right patient at the right time"
Respondents mentioned that interventions performed had many benefits to patients, pharmacy profession and healthcare system	20	"You make life of the patient better through such contributions because the intervention makes sure that quality drugs are accessible to the patient and patients are saved from harm"
		"It's useful financially to the health system and also prescribers comply with formularies, guidelines and protocols for the treatment of our patients.
Respondents mentioned that they sometimes document the interventions made and expressed the importance of documentation	18	"We sometimes, frankly, not always, document in medical notes or specially designed departmental form"
		"…my problem is that most people don't like documenting things. But I think that we seriously have to look at documentation because if you don't document, you would not have any evidence of what has been done."
Respondents admitted to the inadequacy of the first degree in Pharmacy in equipping one to actively participate in contributing to pharmacotherapy	16	"I wouldn't say BPharm is adequate enough for you. I have realized that the theory from school is different from practice. In a teaching hospital like this, you have more complex patients and it is sometimes difficult to review patients' records and contribute to pharmacotherapy."
Respondents recommended for a nationwide adoption of this practice	6	"With the numerous benefits to patient care by improving medication safety, I recommend the Ministry of Health to adopt this practice nationwide"

4.4.2 Clinical Intervention Process

Respondents also described the process used in performing clinical interventions following a sequential order. Five major steps were identified which included: gathering of information, identification of clinical issues, development of pharmaceutical plan, implementation/ communication and monitoring. Figure 4.5 shows a schematic representation of the various steps taken by participants in their clinical intervention process.

Step 1: Gathering of information

Interviewees mentioned that they gathered relevant information by reviewing patients' medical notes, talking to patients, their relatives, nurses or physicians. Two participants described how they gathered information on patients:

> *"In obtaining relevant information, we review patients' medical and biomedical records like the LFT`s. An example is a patient may be on a correct dose or frequency of a drug but it was contraindicated because the LFT`s was deranged so there comes the need for varying dose frequencies for that particular patient."* ***(Participant004)***

> *"Participating in ward rounds with other healthcare professionals also provided pharmacists the opportunity to discuss the patients in details and thereby obtain first-hand patient information."* ***(Participant 001)***

Step 2: Identification of issues

Respondents then identified pharmaceutical issues that required interventions. The issues mentioned were medical problems or drug errors. The issues formed the basis for the interventions. They included prescribing errors, dispensing errors, drug administration errors, monitoring requirements, counselling requirement, and adverse drug reaction reporting. A quote illustrates this point:

> *"You look at the diagnosis, look at the vital signs, relate it to the medications and find out if there is any problem. You watch out for drug-drug interactions, adverse effects related to the medication. We have the opportunity to look at lab reports and other*

investigations. We look at other parameters like urine output, blood sugar, patient weight and link it to patients' medication too." ***(Participant 011)***

Step 3: Development of pharmaceutical plan

After the problems had been identified, a plan was designed. The plan involved the actions to be taken to resolve the problem. This was illustrated by respondent:

"We start by assessing the identified problems, using the background knowledge in drug therapy. After assessing the problems we plan on how the changes can be made. This involves consulting the medical practitioner in charge of the said patient." ***(Participant 001)***

Step 4: Communicating/Implementation of plan

After a plan has been developed, it is either communicated or implemented. Pharmacist compared the plan with local, regional or international protocols. These plans were patient centred as summarised by a respondent:

"Usually once you identify a problem, you need to draw the attention of the other healthcare professionals about the problem identified and obviously help find a solution to it. Sometimes you will get queries demanding a defense to your point, most of which is done verbally." ***(Participant 005)***

Step 5: Monitoring or feedback

Respondents mentioned that this stage of the process was to compare results with desired outcomes and ensured minimum side effects. Two excerpts are provided below:

"When all is said and done, you cannot go to sleep. You have to plan to monitor the interventions made. You will need feedback of a sort. Say, clinical outcome etc" ***(Participant 002)***

"After that, we evaluate the changes." ***(Participant 005)***

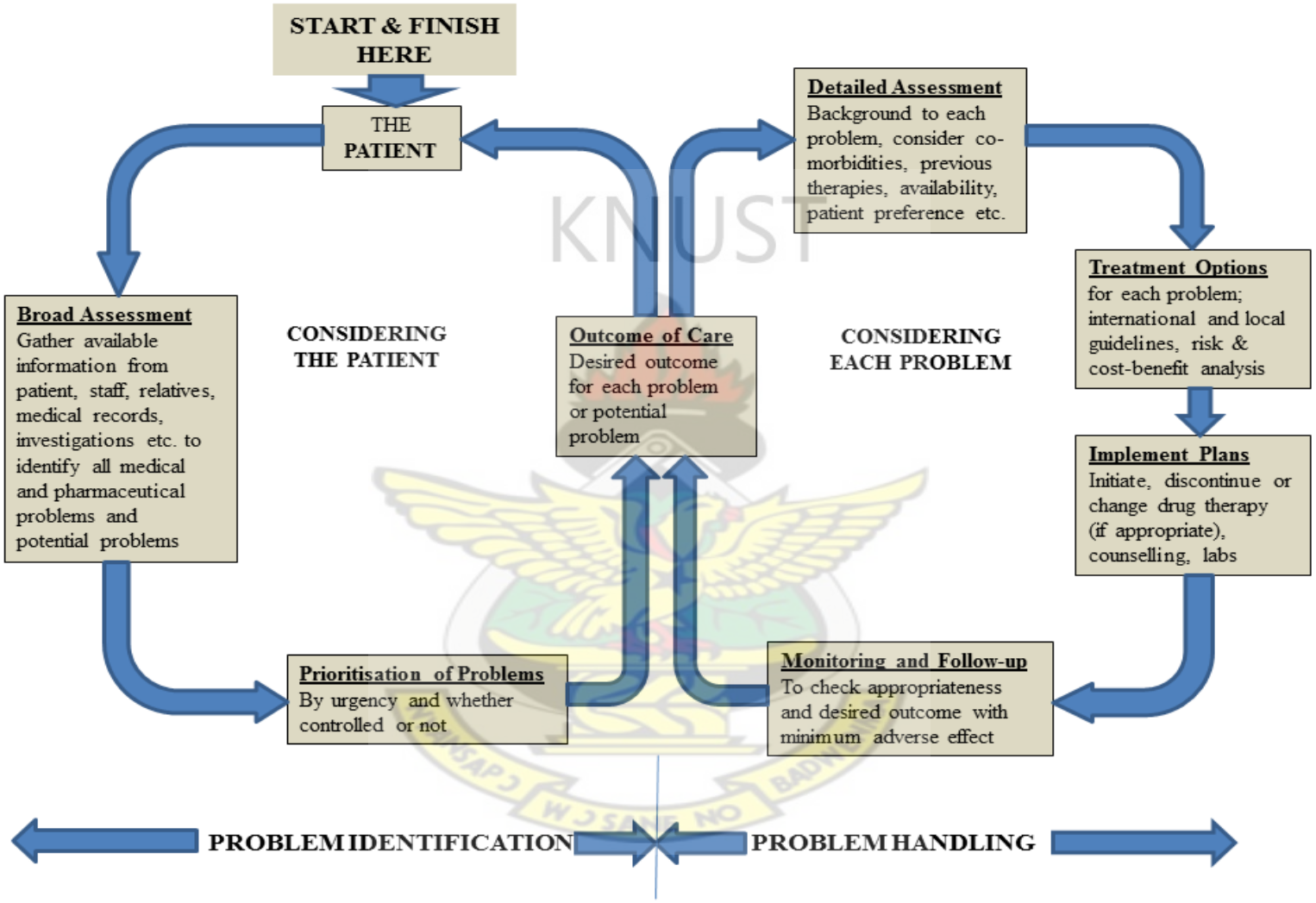


Figure 4.5: Schematic representation of clinical interventions process

4.4.3 Barriers to Performing Clinical Interventions

All respondents stated that they experienced one challenge or another. Three secondary categories were identified as potential barriers to performing interventions. They included workload, lack of clinical knowledge and attitudes of doctors and nurses.

a) Workload

All the interviewees mentioned that workload was a challenge they encountered daily. They commented that they had to perform other roles like dispensing, stock management etc. in addition to clinical roles.

> *"But sometimes the workload becomes too much to bear that you even want to run away even though I think its fulfilling especially when you see a patient get better because of an intervention you made*." ***(Participant 003)***

> *"Because of time factor, it is very difficult for me to go on ward rounds to identify patient care issues and then make the necessary interventions. The same person is managing the pharmacy, attending meetings and so on*." ***(Participant 004)***

b) Lack of adequate clinical knowledge,

Adequate clinical knowledge is essential to undertake effective clinical roles. Ten out of the 12 participants agreed that another major barrier was lack of clinical knowledge. Participants supported the need for postgraduate degree qualification for pharmacists to undertake this clinical role effectively. Two participants illustrate this:

> *"Sometimes you feel inadequate, in terms of clinical knowledge and extra training will be helpful. The first degree is not adequate because it makes it difficult for you to make contributions into challenging issues."* ***(Participant 002)***

> *"It's sometimes intimidating because probably it's a consultant you are going to see and you are scared you don't have your facts right. And the doctors come to the wards in bunches and we go single handedly."* ***(Participant 010)***

Participants also mentioned the lack of specialist training. Participants believe that will contribute to enhancing clinical knowledge.

"What I am doing is general clinical pharmacy and I feel inadequate sometimes because the cases are specialist cases. If I were to specialize in a particular area for example, cardiology, I think I would perform better. And also it will add more width to my work and people will appreciate my input more because I will have more knowledge in a particular field." ***(Participant 011)***

In contrast, a participant suggested that Pharm D qualification will put pharmacy graduate more in readiness to perform clinical roles immediately.

"I preferred Pharm D. training program which seeks to make the pharmacist very capable of providing clinical care at the point of completion of the course." ***(Participant 006)***

c) Doctors' and nurses' attitudes

In the clinical settings, pharmacists work closely with other healthcare professionals, especially doctors and nurses. Participants mentioned that another major barrier to their clinical role was the attitudes and perceptions of doctors and nurses. The statements below summarise the point:

"There is this attitude of looking down on others by doctors because of professional differences or backgrounds, and they probably feel that one is questioning their authority. Doctors, especially feel superior because they are ultimately responsible for the patient; they overuse that. It is purely an issue of ego." ***(Participant 012)***

"A typical example was when a prescription of vitamin C 3000 mg was written for a child of 2 years by a house officer. I quickly wrote a note to indicate the error in the prescription. He sent it back insisting that it be given. He was particularly rude. I went to him personally to inquire reasons he was insisting that dose be given to a child of 2 years. It became a rather tense and confrontational situation and I told him that unless he changed the prescription I wasn't going to dispense the drug. " ***(Participant 005)***

Some doctors and nurses are ignorant of the clinical competence of pharmacists and these have the potential of influencing their attitudes toward pharmacists. Below are some quotes from what they said:

> *"There is this mentality that doctors are to take care of patients and pharmacists are to look after drugs without any consideration to how they were used at all."* ***(Participant 011)***

> *"There is always that doubt about the competence of pharmacist by other professionals. Doctors are trained that one has to prove his worth to be able to play a role in patient management so it is only natural that there will be some difficulty in accepting another person who was not trained the same way as doctors."* ***(Participant 010)***

> *"There has to be a form of platform that seeks to inform them of our abilities and readiness play clinical roles and not just our traditional roles of dispensing, manufacturing and the rest. We have evidence. For example, when we got actively involved in HIV care, our patients are well educated and we are achieving 90 % adherence and most of our patients are doing well."* ***(Participant 012)***

> *"People even think that when it comes to hospital, its doctor or nurse, finish!. Even though doctors and nurses appreciate our work they seem to forget themselves sometimes and forget our clinical roles."* ***(Participant 003)***

Lack of proper communication skills can also create unfavourable working relationships with others and lead to improper attitudes.

> *"Unfortunately the premise of interventions is more like corrective and if you don't have the right skills to make recommendations, they will become defensive. No one wants to be told they have done mistakes, especially doctors. "* ***(Participant 011)***

> *"Your approach, communication is very important, if you don't approach properly, then the other one thinks you are discrediting his role or questioning his integrity or knowledge, there must be rapport such that the person would accept your input."* ***(Participant 002)***

Lack of cooperation was also mentioned by participants as a barrier. Interviewees perceived that it sometimes appeared as if doctors and nurses were protecting their turf. The following illustrates the assertion:

> *"It is purely the lack of collaboration and cooperation. If the system does encourage people to meet and work together in the interest of your patient, then it's easier for everybody to cooperate."* ***(Participant 007)***

> *"There is the mentality that doctors and nurses are supposed to be taking care of patients and we are supposed to be taking care of products without consideration to how they were used. The thought of trying to be doctors by adding patient care to our responsibilities will lead to them asking for the same benefits they receive."* ***(Participant 012)***

4.5 Section Four: Perceptions of Doctors and Nurses

Of the 320 questionnaires administered, a total of 269 were retrieved representing a total response rate of 84.1%. The response rates were 86% (n=172) and 80.8% (n=97) for doctors and nurses respectively. Demographics and other relevant characteristics are presented in Table 4.21.

Table 4.21: Characteristics of study participants (N=269)

Characteristic	**n (%)**
Doctors (n=172)	
Gender	
Male	113(65.7)
Female	59(34.3)
Current position	
House officer	41(23.8)
Medical officer	9(5.2)
Senior medical officer	3(1.7)
Resident	69(40.1)
Senior resident	15(8.7)
Specialist	17(9.9)
Consultant	18(10.5)
Nurses (n=97)	
Gender	
Male	8(7.3)
Female	89(92.7)

Table 4.21 (continued): Characteristics of study participants (N=269)

Characteristic	n (%)
Current position	
Staff nurse	35(37.2)
Senior staff nurse	14(14.9)
Nursing officer	17(18.1)
Senior nursing officer	7(7.4)
Principal nursing officer	20(21.3)
Deputy director of nursing services	1(1.1)
Current area of practice of doctors & nurses	
Internal medicine	48(17.9)
Surgery	76(28.4)
Obstetrics & gynaecology	34(12.7)
Paediatric	46(17.2)
Emergency	32(11.9)
Orthopaedic	9(3.4)
Others*	23(8.6)
Experience of doctors & nurses(years)	
Mean (±S.D)	6.9(±6.96)
Median (range)	5(1-34)

*others: ENT, EYE, Maxilofacial, radiotherapy, anaethesia, central OPD, cardiothoracic unit, dental)

Doctors' and nurses' interaction with Pharmacists occurred sometimes during their routine hospital duties. More than two thirds of sampled doctors (82.6%) and nurses (78.4%) stated that they interacted with pharmacists. Sixty percent of doctors and 59% of nurses stated they were satisfied with the interactions they had with pharmacists (Figure 4.6). The main reasons for the interactions related to seeking drug information (62.6%) and drug availability challenges (60.8%) as shown in Table 4.22.

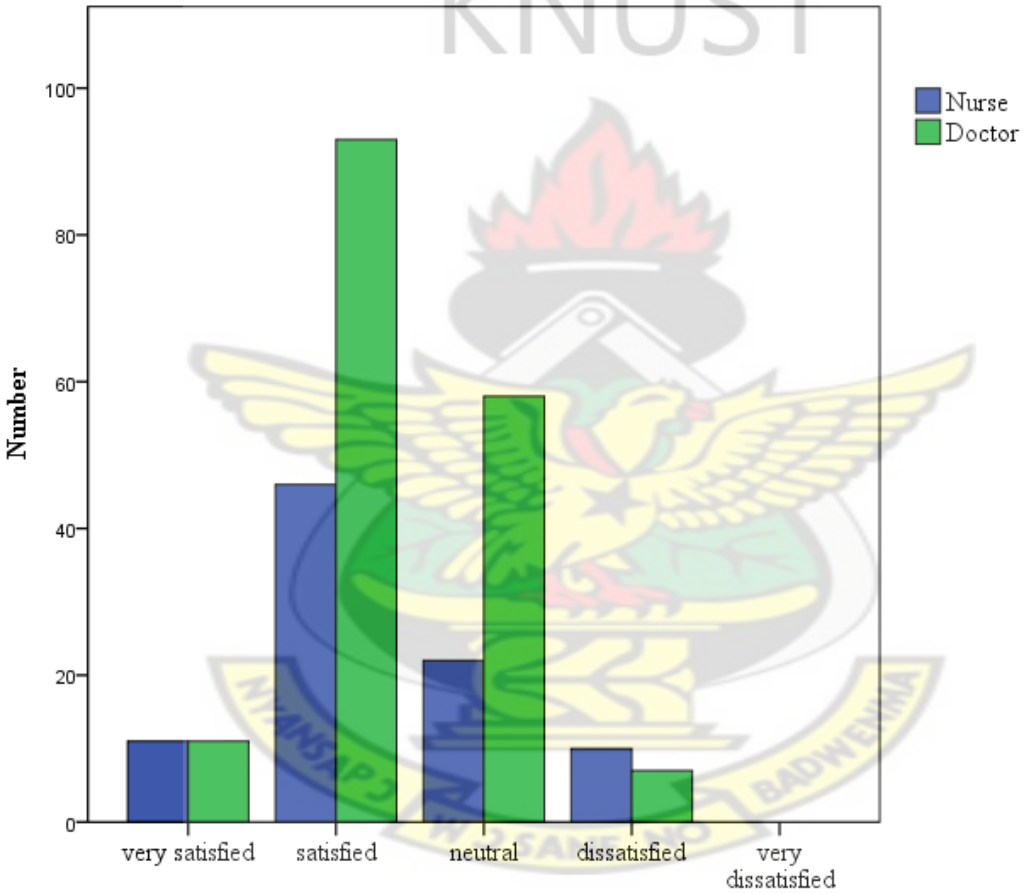


Figure 4.6: Degree of satisfaction while interacting with pharmacists

Table 4.22: Reasons and the frequency of interactions between respondents (doctors & nurses) and pharmacists

Frequency of interaction	**n (%)**
Always	57(21.5)
Sometimes	161(60.8)
Rarely	40(15.1)
Not at all	7(2.6)
*Reasons for interactions**	
Seek for drug information	166(62.6)
Drug availability challenges	161(60.8)
Patient drug therapy queries	95(35.8)
Side effects & adverse drug reactions reports	71(26.8)
Discuss patients' medication use	89(33.6)

* More than one choice was applied

Of the sampled respondents, 7.6% doctors and 22.1% nurses indicated that they always had pharmacists to contribute to medication use. Moreover a third of doctors (37%) and nurses (33%) thought that the collaboration with pharmacists had always enhanced drug related patient safety (see Table 4.23 & 4.24).

Table 4.23: Experiences and perceptions of doctors on interacting with hospital pharmacists

Experience	Always n (%)	Sometimes n (%)	Rarely n (%)	Not at all n (%)
Do you get pharmacist to contribute to medication use in your practice?	13(7.6)	107(60.6)	47(27.6)	7(4.1)
How often are you satisfied with their contribution?	51(30.7)	108(65.1.)	6(3.6)	1(0.6)
Do you think the collaboration with pharmacists has enhanced drug related patient safety?	61(37.2)	84(51.2)	19(11.6)	0(0.0)
Do you think pharmacists are a reliable source of clinical drug information?	67(39.4)	92(54.1)	10(5.9)	1(0.6)
Would you consider pharmacists actions as being very patient centered?	35(21.0)	106(63.5)	25(15.0)	1(0.6)

Table 4.24: Experiences and perceptions of nurses on interacting with hospital pharmacists

Experience	Always n (%)	Sometimes n (%)	Rarely n (%)	Not at all n (%)
Do you get pharmacist to contribute to medication use in your practice?	21(22.1)	46(48.4)	19(20.0)	9(9.5)
How often are you satisfied with their contribution?	28(30.4)	42(45.7)	11(12.0)	11(12.0)
Do you think the collaboration with pharmacists has enhanced drug related patient safety?	31(33.0)	42(44.7)	11(11.7)	10(10.6)
Do you think pharmacists are a reliable source of clinical drug information?	53(55.8)	35(36.8)	2(2.1)	5(5.3)
Would you consider pharmacists actions as being very patient centered?	29(31.2)	44(47.3)	9(9.7)	11(11.8)

Table 4.25 provides summary of orthogonal (varimax) rotation results of the factor analysis. Factors with Eigenvalue greater than 1 were retained. Four factors were loaded. Details of component items of the various factors are presented in Appendix 3.21. The loadings appeared to consist of two main groups (representing >70% of the 4 factors). These can be classified as traditionally accepted pharmacists' roles and non-traditional roles. These non-traditional roles may consist of perceived traditional doctors' and nurses' roles and other commonly shared roles.

Table 4.25: Results for the Extraction of Common Factors

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.137	38.746	38.746	8.137	38.746	38.746	5.865	27.93	27.93
2	3.019	14.374	53.120	3.019	14.374	53.12	4.682	22.294	50.223
3	1.465	6.976	60.096	1.465	6.976	60.096	1.745	8.307	58.531
4	1.137	5.416	65.511	1.137	5.416	65.511	1.466	6.981	65.511
5	0.902	4.293	69.804						
6	0.735	3.499	73.303						
7	0.595	2.833	76.136						
8	0.592	2.818	78.954						
9	0.557	2.650	81.604						
10	0.485	2.311	83.916						
11	0.442	2.106	86.022						
12	0.419	1.993	88.015						
13	0.364	1.732	89.746						
14	0.352	1.674	91.420						
15	0.329	1.567	92.987						
16	0.315	1.500	94.488						
17	0.298	1.417	95.905						
18	0.254	1.208	97.112						
19	0.242	1.151	98.263						
20	0.194	0.923	99.186						
21	0.171	0.814	100.00						

Extraction Method: Principal Component Analysis

A summary of the degree of acceptance of traditional roles resulting from factor groupings is presented in Table 4.26. In general, doctors were more likely than nurses to accept perceived traditional roles of pharmacists. However, non-resident grade doctors were significantly more likely to accept perceived traditional roles of pharmacists. Lower- ranked nurses (Nursing officer grade and below) appeared more likely to accept perceived pharmacists' traditional roles.

Table 4.26: Contingency table of variables and degree of acceptance of traditional roles

	Accepting perceived traditional roles	χ^2	df	p-value
Doctors (n=171)	146	22.281	4	<0.001
Non-Resident Grade physician (103)	60	3.634	4	0.045
Junior grade nurse (staff nurse, senior staff nurse, nursing officer) (n=66)	51	14.398	4	0.006
Less or equal to 3 years of work experience (n=66)	53	2.814	4	0.050

Table 4.27 describes the level of agreement of doctors and nurses to what the roles of pharmacists in the hospital should be. Only 39.9% and 31.4% of respondents agreed that pharmacists write refill prescriptions and treat common ailments respectively. Just more than half (53.8%) agreed that pharmacists reconstitute I.V preparations for administration.

Eighty percent and 85.3% agreed that pharmacists provide drug information and report on medication errors respectively. Participants who had spent more than 3 years in practice were twice as much in agreement to pharmacists designing and monitoring pharmacotherapeutic regimens (P=0.046). Doctors were twice as much less likely to agree that pharmacists monitor effectiveness and side effects of medication (P=0.006). However twice as much doctors agreed that pharmacists write refill prescriptions for existing therapies (P=0.038). More nurses than doctors agreed that pharmacists intervene to prevent prescribing and administration errors from reaching patients (P<0.001), provide discharge counseling (P=0.015), treat ailments of common occurrence (P<0.001), and report on medication errors and adverse drug reactions (P<0.001). Residents were more likely to disagree that pharmacists intervene to prevent medication errors (P=0.036) but less likely to disagree that pharmacists treat common ailments (P=0.001).

The responses to the open-ended questions that solicited for additional ways pharmacists could enhance their medication safety roles were grouped into categories. Majority of the responses related to the active participation on ward rounds, organization of regular medication-safety-update meetings and deployment of specially trained safety officers. Doctors wanted pharmacists to obtain additional training in safety measures whiles nurses expected pharmacists to increase their presence at the wards and actively provide drug updates on regular basis.

The suggestions of doctors and nurses in response to the open-ended question related to pharmacists increasing their participation on ward rounds, organization of regular workshops on new drugs and intensifying side effect monitoring of drugs.

Table 4.27: Degree of agreement with what hospital pharmacists' activities should be

Activities	% in agreement		% not in agreement	
	Doctors	**Nurses**	**Doctors**	**Nurses**
Provide patient education on their medicines	85.9	78.1	14.1	21.9
Monitor effectiveness and side effects of patients' medication	78.1	62.5	21.9	37.5
Recommend drug therapies to doctors	74.9	71.6	25.1	28.4
Intervene to prevent prescribing and administration errors from reaching patients	93.0	75.8	7.0	24.2
Design and monitor patients pharmacotherapeutic regimes	70.8	64.6	29.2	35.4
Write refill prescriptions for existing therapies	35.3	48.4	64.7	51.6
Provide discharge counselling on medication use	75.9	61.7	24.1	38.3
Treat ailments of common occurrences	22.9	46.8	77.1	53.2
Participate constantly and effectively with doctor teams	86.5	70.8	13.5	29.2
Reconstitute I.V preparations for administration	57.9	46.3	42.1	53.7
Dispense medication	81.7	86.0	18.3	14.0
Report on medication errors and adverse drug reactions	92.4	72.6	7.6	27.4
Actively provide reliable drug information to other healthcare professionals	91.2	82.3	8.8	17.7

More than 90% of respondents expected pharmacists to provide medication education to patients. Doctors and nurses differed in their expectations on some of the future roles of pharmacists. Almost 42% of doctors did not agree that pharmacists should use their knowledge and skills to alter drug regimens to the best interest of patients whiles only 19% of nurses did not agree. However, slightly more doctors (88%) than nurses (84%) want

pharmacists to take responsibility for resolving drug-related problems. Expectations of respondents have been presented in Table 4.28.

Table 4.28: Doctors' and nurses' expectations of pharmacists' clinical role(s)

Description of role	Agree (%)		Neutral (%)		Disagree (%)	
	Doctors	**Nurses**	**Doctors**	**Nurses**	**Doctors**	**Nurses**
Assist prescribers in selecting appropriate medications	88.8	91.7	10.0	3.1	1.2	5.2
Take responsibility for resolving drug-related problems	84.6	87.5	11.2	7.3	4.2	5.2
Become knowledgeable drug-therapy experts	91.7	90.6	7.7	4.2	0.6	4.2
Provide patient medication education	94.1	91.7	4.7	5.2	1.2	3.1
Use their knowledge and skills to alter drug regimes in the best interest of patients	58.0	80.2	25.4	9.4	16.6	9.4
More patient oriented professionals than just dispensers and compounders of medication	91.7	87.5	7.7	9.4	0.6	3.1
Assist in designing hospital-specific therapeutic protocols for various diseases	92.9	86.5	5.3	9.4	1.8	4.2
Assist in selecting cost effective drug therapies	93.5	84.4	5.3	11.5	1.2	4.2

Chapter 5

5 Discussions

5.1 Medication Administration Errors (MAEs)

Of the 362 MAEs recorded in this study only one was potentially fatal, however 26 were definitely clinically severe which required the intervention of another staff to prevent them from reaching the patients. The error rate was 27.2%, when wrong time error was accounted for and 22.8% when they were excluded. The error rate of 27.2% was lower than the 34.8% detected in a study by Patanwala et al. (2010) and the 44.6% error rate reported by a Dutch ICU study (van den Bemt et al., 2002). The error rate for IV doses in this study was 13.8%. This was higher than the 5.6% obtained as the average of UK MAE rates by McLeod and colleagues (2013). However, a report from another UK study gave a wider range of 49-94% error rate for IV doses (Vincent et al., 2009). In many studies wrong time errors was the highest type of administration errors (Chua et al., 2010, Patanwala et al., 2010, Ozkan et al., 2011, Agalu et al., 2012, Berdot et al., 2012) but this came after omission error in this study. Majority (63%) of the omission errors were due to unavailability of medication at the time of drug rounds. This may be due to the inefficiencies in the drug supply system at the time of the study- patients paying out of pocket for medicines that were not covered by medical insurance.

This study found a relationship between parenteral use and night shift with the occurrence of errors. Parenterals alone represented 49.5% of the error rate identified which is comparable to studies that reported proportions around 45% (Taxis and Barber, 2004, Taxis and Barber, 2003a, Hoefel et al., 2008) . Parenteral administrations pose particular risks because of their greater complexity and the multiple steps required in their preparation, administration and monitoring. In literature, the night shift has been reported to have different associations with errors. Berdot and colleagues (2012) reported no risk while other studies found otherwise (Patanwala et al., 2010).

Though the number of months spent in the ED unit had no significant bearing on the errors recorded, the study showed that staff that had 10 or more years' experience were 2.17 more likely to have been involved in error. A plausible explanation is that some of the older staff had acquired in their routine activities error friendly habits. The study also found an association between MAEs and workload (the number of patients under nurse care) as in other studies (Tissot et al., 2003, Berdot et al., 2012).

The study also sought to identify possible causes of those errors. The possible factors were varied; from drug unavailability to staff characteristics. There was therefore the need to understand the potential contributory factors to these errors from the viewpoint of the staff involved.

5.2 MAE Provoking Factors

The study used Reason's human theory of error causation to explore the latent factors and error provoking conditions of administration errors in emergency settings in hospitals. Many factors were mentioned in responses which included patient, individual staff, team, work environment and organisational factors. The patient factors included patients taking prescribed medicines on their own, language barrier, and complexity of diagnosis. Some staff factors identified included lateness, personal issues, lack of concentration and tiredness. The rest of the contributory factors included overcrowding, distractions, poor communication and lack of medication administration protocols.

The use of interviews provided better understanding of the contributory factors. This compares with other studies done in different settings of different hospitals (Lawton et al., 2012). Important prevalent factors identified were interpersonal conflicts among staff and patient's beliefs. Reason (1995b) defined *Safety Culture* as shared values and beliefs that interact with an organization's structures and control systems to produce behavioural norms. The identified themes in this study can be classified under both the shared values and beliefs associated with medication safety and the potential failures in the organization's structure and control systems. According to Reason, staff factors identified in the study were rules and norms that have evolved over time and which have forced individuals and teams to adapt to them. Work environment was the most commonly cited as in other studies and would require setting-specific approaches in dealing with it (Lawton et al., 2012, Sanghera and Franklin, 2007). In particular, the ED allowed relatives to visit their patients at all times. This should be discouraged and arrangements made to reduce distractions during medication administration. Overcrowding and poor physical ward arrangement was also cited as aspects of the immediate working environment which hinder the provision of safe patient care and encourage the performance of unsafe acts. Workload was also contributory factor to error. This factor is one of the most significant reasons for situational violations. High patient-nurse

ratio causes workload/time pressure (Brady et al., 2009). A study by Tang et al. (2007) found that nurses rush because of workload and therefore make mistakes. Workload is one of the factors contributing to errors in the ward and must be solved at the institutional level. Poor supervision was also identified. Junior nurses stated that most times more experienced staff were not readily available to clarify issues with. Insufficient protocols on medication preparation and administration contributed to violations. It was explained that the lack of common equipment like tablet-crushers forces nurses to resort to crushing tablets in folded paper. This situation can be interpreted as a violation of institutional rules. Frequent violations by nurses to rules have also been reported by previous researchers (Taxis and Barber, 2003b). Though this study revealed violations, analysing the underlying cause points to a systemic problem. Moreover interviewees blamed their lack of knowledge on inadequacy of their training. Most cited the difficulties during their first few days on the job. Nurses' training institutions would need to re-evaluate their modules on medication administration to address this issue.

Many interventions have been studied and found to enhance medication safety. Chiefly among them has been the participation of pharmacists in all the stages of the medication use process. It was therefore useful to explore the medication safety activities that pharmacists in hospitals employed to contribute to medication error identification and prevention.

5.3 Medication Safety Activities of Pharmacists

The study sought to explore the activities of hospital pharmacists. The results showed that pharmacists in hospital undertake many different medication related activities that enhance medication safety. They also supervise many of these activities which are undertaken by other members of the pharmacy team such as pharmacy technicians and pharmacy assistants. Their role has however evolved over time to become more patient oriented (Hepler and Strand, 1990).

If well channelled, pharmacists are particularly well positioned to provide the necessary medication instruction to patients, which is an overarching recommendation of the Institute of Medicine's Committee on Identifying and Preventing Medication Errors (Hanlon et al.,

1996). They may also provide drug monitoring and corresponding feedback to assist physicians in prescribing decision making and laboratory monitoring.

The limitations on health care resources especially in developing countries necessitate careful focus on activities that lead to the greatest improvement in patient outcomes. It is therefore important that health institutions align pharmacists' time with activities that will derive the most impact.

Pharmacists from the study rated their role in medication safety very highly. They thus accepted such roles in the hospital setting as shown by many researchers (Klopotowska et al., 2011b, Murray et al., 2009, Kwan et al., 2013, Vincent et al., 2009, Vincent, 2010, Veggeland and Dyb, 2008). Regardless of where pharmacists work in the hospital, there were similar clinical activities that compared with works of other authors. In 1034 ICUs in US hospitals, pharmacists were engaged in providing drug information, drug therapy evaluation, drug therapy intervention, and pharmacokinetic monitoring (Maclaren et al., 2006), medication reconciliation in geriatrics (Boockvar et al., 2006), review medication orders in emergency department (Patanwala et al., 2012) and managed antimicrobial prophylaxis in surgical site (Bond and Raehl, 2007a).

The study found that pharmacists largely participated in activities that literature perceived to result in the safe use of medicines in hospitals. This was evident by the time spent on those activities although it was not uniform across the various hospital settings. They also confirmed their convictions of this involvement. Similarly, the data shows their beliefs that their activities provided benefits to patient care outcomes however, we could not establish the extent to which their activities align with patient care outcomes (Loewen et al., 2010) since it was beyond the scope of this study. Pharmacists also believed that physicians and nurses were involved in medication safety. This is essential to foster the collaboration needed to undertake this task.

A systematic review had identified the use of pharmacists' participation in some of the safety measures in this study as having positive impact on patient care (Kaboli et al., 2006b). Their study concluded that the addition of clinical pharmacist services in the care of inpatients generally resulted in improved care, with no evidence of harm. These include 6 of the activities in this study. Interacting with the health care team on patient rounds, interviewing patients, reconciling medications, and providing patient discharge counselling and follow-up

all resulted in improved outcomes. Bond and Raehl (2007b) found 7 of the clinical pharmacy activities undertaken in this study to be associated with reduced mortality rates: pharmacist-provided drug use evaluation (4491 reduced deaths), pharmacist-provided in-service education (10,660 reduced deaths), pharmacist-provided adverse drug reaction management (14,518 reduced deaths), pharmacist-provided drug protocol management (18,401 reduced deaths), pharmacist participation on the cardiopulmonary resuscitation team (12,880 reduced deaths), pharmacist participation on medical rounds (11,093 reduced deaths), and pharmacist-provided admission drug histories (3988 reduced deaths).

It is expected that pharmacists will spend more time on activities they perceive to have the greatest impact (Loewen et al., 2010). The study found the average of 5.6-19.8hours per week confirming the perceived importance pharmacists place on such clinical duties. Most pharmacists spend most of their time counselling out-patients. This was done in the process of dispensing which is the topmost traditional role of pharmacists.

Unlike other studies (Loewen et al., 2010), pharmacists in the study spent less time on monitoring side effects, IV reconstitution, laboratory reviews and reconciling medications. In most Ghanaian hospitals, reconstitution of medicines, with the exception of oncology drugs, is mostly done by nurses at their respective wards. These roles need to be investigated further since studies had confirmed the concerns about nurses' lack of adequate training in handling IV medications (Taxis and Barber, 2004, Taxis and Barber, 2003b, Wilkinson, 1996, Campbell and Lunn, 1997, Westbrook et al., 2011). It will be recommended that pharmacists in the country take up the role and adopt central preparation of IV medication.

The study then sought to review documented evidences of hospital pharmacists to collaborate the opinions they had expressed on their medication safety.

5.4 Documented Clinical Interventions

The study evaluated the clinical intervention reports submitted by pharmacists working in a tertiary hospital, explored the process involved and the potential barriers to pharmacist clinical interventions. The pharmacists identified drug related problems in the management of patients and made interventions to prevent these errors from reaching patients. Twenty-four pharmacists made 1019 clinical interventions in 448 handwritten reports. Majority of the

interventions related to drug therapy changes. Though this study evaluated handwritten reports, it is comparable to evaluations done on electronic incident reports (Budnitz et al., 2006, Tariq et al., 2012).

The categories of drugs most often associated with drug error reports were similar to those reported from previous studies and included cardiovascular agents (Lesar et al., 1997b, Kuo et al., 2008), anti-infectives (Kuo et al., 2008, Silva et al., 2013), and central nervous system agents (Hansen et al., 2006, Lesar et al., 1997b), suggesting that future strategies for reducing drug errors could target these agents. This study also found challenges with the use of nutritional supplements. Most of the challenges with nutritional supplements had to do with untreated anaemia, which physicians had overlooked. Iron deficiency anaemia is a serious nutritional problem in developing countries given its impact on increased mortality or serious morbidity in patients (DeMaeyer, 1989).

The frequently reported drug was warfarin as found in other studies (Gurwitz et al., 2007). The use of warfarin presents substantial safety concerns for patients. Adverse events associated with warfarin therapy are common (Zhan et al., 2008). This will require prevention strategies targeted at the prescribing and monitoring stages of warfarin management.

Though this study concentrated on pharmacists identifying inpatient drug errors as in other studies, results are comparable with studies conducted in outpatients (Kuo et al., 2008, Aljadhey et al., 2013, Bourgeois et al., 2009, Murray et al., 2009, Sarkar et al., 2011). The drug errors assessed in this study were reports from only pharmacists although physicians (Scott et al., 1990, Kuo et al., 2008), nurses (Bates et al., 1995c, Pagnamenta et al., 2012) and others (Hartwig et al., 1991, Costa et al., 2008) had reported drug errors in other studies.

The most frequently reported drug errors found in our study were drug regimen change and originated from drug prescribing. This finding is consistent with findings from other studies conducted in clinical centres (Franklin et al., 2011), tertiary (Al-Jeraisy et al., 2011), hospital inpatient (Dean et al., 2002b) and ambulatory care settings (Kuo et al., 2008). Inappropriate prescribing predicts the risk of adverse drug events (Lund et al., 2010). The most commonly reported prescribing drug error was untreated indication. This was followed by prescribing wrong dose as seen in other studies (Kuo et al., 2008, Raju et al., 1989). Children are particularly at risk of wrong dose errors (Fernandez-Llamazares et al., 2013).

The top two most frequently reported drug type associated with prescribing, dispensing and administration errors were cardiovascular and anti-infective agents. The most commonly reported dispensing error was dispensing wrong drug. Previous studies have reported dispensing wrong drugs in all types of inpatient settings (Costa et al., 2008, Rolland, 2004, Roberts et al., 2002, Facchinetti et al., 1999, Bohand et al., 2009). Omission due to drug unavailability was also a common error identified. Drug unavailability is common and poses a major challenge to healthcare systems in transitional and developing countries (Agalu et al., 2012, Nunes et al., 2013). In addition to drug omissions, administering wrong drug followed by duplication were common reported administration errors. The most commonly reported monitoring error was omitting relevant laboratory test. Monitoring errors had been previously reported (Kuo et al., 2008).

More than 90% of interventions and recommendations by pharmacists were accepted and implemented. Over 70% of the interventions involved drug regimen change. Studies have reported prescribing errors as a major contributor to patient harm in hospitals (Dean et al., 2002b, Franklin et al., 2011, Lund et al., 2010, Lewis et al., 2009, Lesar et al., 1997b). Most (76%) of the interventions were communicated verbally. This would require an operational collaborative working relationship between pharmacists and other healthcare professionals to enhance patient care (McDonough and Doucette, 2001). Previous studies reported that pharmacists in a collaborative team in hospitals helped reduce adverse drug events by 30–86% (Patanwala et al., 2012, Murray et al., 2009, Leape et al., 1999a, Klopotowska et al., 2011a). Pharmacists' close proximity with physicians provides opportunity for timely verbal communications on error interceptions. Some of the potential risk prevented by pharmacists included bleeding, anaemia, nephrotoxicity, electrolyte imbalance, severe diarrhoea etc.

Moreover, other interventions by pharmacists in this study related to patient counselling. It has been reported that patient counselling prevent adverse drug events during and after hospitalisation (Schnipper et al., 2006).

Error recovery interventions of pharmacist provide benefits to the healthcare system. However there are some barriers to performing interventions. Understanding these barriers could assist in enhancing the clinical intervention process.

Pharmacists are in an ideal position to provide on-going medication therapy management services for their patients. Error recovery is one of such important roles. Pharmacist

interventions have been shown to positively affect clinical health outcomes such as morbidity and adverse drug events (Gillespie et al., 2012, Leape et al., 1999a). There are however barriers to optimizing such a useful medication safety strategy. When these barriers interfere with the pharmacist's ability to perform interventions, serious errors may reach the patient.

Pharmacists clinical intervention in this study followed a sequential process which was cyclical in nature (see Figure 4.5). The attributes of the process compares with the process of providing pharmaceutical care which has been described as a continuous quality improvement process for the use of drugs (Oparah and Eferakeya, 2005). Helper and Strand described pharmaceutical care as the responsible provision of drug therapy for the purpose of achieving definite outcomes that improve or maintain a patient's quality of life (Hepler and Strand, 1990). Researchers have viewed pharmaceutical care as a vital component to providing patient care. Pharmacists performing clinical interventions can be said to be providing pharmaceutical care. A fundamental element in optimizing patient outcomes is the routine addition of ongoing monitoring to the medication use process through the provision of pharmaceutical care (MacKinnon, 2002).

The barriers to clinical interventions mentioned by interviewees related to workload, inadequate clinical knowledge and attitudes of doctors and nurses. Workload negatively affects pharmacists' performance on various activities undertaken at various settings (Malone et al., 2007, Kreling et al., 2006, Svarstad et al., 2003). Workload has been known as potential causes of medication errors (Dean et al., 2002a). In a study, pharmacist's willingness or ability to intervene in the case of prescription problems decreased as the volume of prescriptions dispensed increased (Rupp et al., 1992). Leape et al.(1995) also found that workload was a contributory factor to adverse drug events and recommended reducing workload in hospitals. Managerial schedules compete strongly with clinical roles as they were often understaffed. Increased clinical pharmacist staffing has been shown to result in enhanced patient outcomes by decreasing adverse drug reactions in hospitals (Bond and Raehl, 2006). This should result in dedicating well-trained staff to engage in medication safety activities.

Pharmacists mentioned that their inadequate clinical knowledge affected their performance. Appropriate knowledge about therapeutics will assist pharmacists in being seen as partners in the clinical management of patients. Physician's familiarity with and respect for a

pharmacist's clinical abilities could support his or her willingness to accept a pharmacist's input. Pharmacists with the requisite clinical training and professional education are positioned to prevent errors and help in patient management because of their knowledge and skills in drug therapy and their accessibility to patients (Pharmacy et al., 2003). Pharmacists are able to blend a caring orientation with specialized therapeutic knowledge, experience, and judgment for the purpose of ensuring optimal patient outcomes (Who Are, 2008).

The negative attitudes of doctors and nurses towards pharmacist were identified as potential barriers. Discrepant attitudes about healthcare teamwork characterised by conflicts and egos resulted from differences in status/authority, responsibilities, training, and nurse and doctor cultures (Thomas et al., 2003). Hughes and McCann (2003) found that doctors did not appreciate pharmacists in healthcare. The role of pharmacists in the care of hospitalized patients has expanded over time, with increased emphasis on collaborative care and patient interaction. Pharmacy practice had to battle with a strict historic model of physicians diagnosing and prescribing while pharmacists compound and dispense. In a study, increased awareness of all team members' (pharmacists, nurses and doctors) potential roles played a part in facilitating positive patient outcomes (Makowsky et al., 2009).

Fundamental to a good working relationship is when egos are set aside and the focus is set on preventing and solving drug-related problems with the intention of providing the best possible care for the patient. Participants had mentioned that a major barrier was the attitude of doctors and nurses. Participants referred to the lack of confidence by these professionals in pharmacists' clinical abilities. This led to lack of acceptance of some of their recommendations. Moreover pharmacists in this study perceived that doctors and nurses accepted more of their traditional roles and they appeared afraid of pharmacists taking over their clinical roles. These perceptions have important implications for the profession and practice of pharmacy as well as health care in general. To optimise the contributions of pharmacists to patient safety, pharmacists need to collaborate with other health practitioners, especially doctors and nurses. The collaboration will result in better appreciation of each practitioner's role and remove wrong perceptions. To build these collaborative working relationships, the opinions, experiences and expectations of doctors and nurses about pharmacists needed to be known and well understood.

5.5 Perceptions of Doctors and Nurses

A response rate of 84.1% obtained in this part of the study was considered very high. This could be attributed to the involvement of departmental heads and also may be due to the fact that most of the questionnaires were administered at clinical meetings, which were highly attended. The study found that pharmacists interacted with both doctors and nurses frequently during their routine work schedule. Reasons for such interactions included both drug availability problems and clinical services. Doctors and nurses were willing to accept that pharmacists expand their clinical roles but disagreed that they engage in roles that were perceived traditional to doctors (such as prescribing) and nurses (such as I.V reconstitution). Doctors and nurses perceived pharmacists to be knowledgeable and very useful in enhancing medication safety. Moreover, doctors and nurses had high future expectations of pharmacists as healthcare team members. Physicians were more likely to accept perceived traditional roles than nurses. In addition, non-resident doctors, junior grades of nurses and participants who had worked 3years or less were more likely to also accept traditional roles than their counterparts.

Pharmacists' interactions with doctors and nurses were frequent which confirms the fact that pharmacists' activities in the hospital were collaborative. It could be inferred that participants who by the nature of their work spend more time with the pharmacists were more likely to accept perceived non-traditional roles of pharmacists. These included resident doctors, senior grades of nurses and participants with more than 3 years of work experience. In the study setting, resident doctors were mainly in-charge of patients under their clinical teams and hence are required to make frequent decisions. They also tend to spend more time at a particular unit and hence interact more frequently with pharmacists. Spending more time with pharmacists was therefore important in accepting non-traditional roles of pharmacists (McDonough and Doucette, 2001). This was also evident as seen with senior grade nurses and participants with more than 3 years work experience.

The majority of doctors (60%) and nurses (59%) were satisfied with the interactions. The results of the study did not deviate widely from previous studies on the interrelationships between pharmacists, doctors and nurses working in the hospital (Boudreau et al., 2002b). The reasons for the interactions have not only included drug availability challenges but other more clinical services. However doctors were reluctant to accept pharmacists' roles that included any aspect of prescribing as seen in other studies (Bailie and Romeo, 1996). These

included writing refill prescriptions and treating common ailments. Though several studies have evaluated pharmacist-doctor team management of drug therapy and have reported improvements in blood pressure, diabetes outcomes, cholesterol levels and depression, there are barriers (Bluml et al., 2000b, Boudreau et al., 2002a, McDonough and Doucette, 2001). Moreover a study described the lack of confidence arising from the inadequacy of the interactions between pharmacists and doctors (Ritchey and Raney, 1981). Liu and colleagues studied collaborative working relationship (CWR) model (Liu et al., 2010) and found that trustworthiness was a significant predictor of CWR as had been previously shown (McDonough and Doucette, 2001) (Figure 5.1). McDonough and colleague described that trustworthiness was an exchange variable that was vital in the development of collaborative relationships, which grows if the pharmacist was able to demonstrate his/her competence. This consistent provision of useful information results in doctor trusting the expertise of the pharmacist. Each party then becomes willing to have open discussions about approaches relating to patient clinical management and about treating specific patients. A Cochrane review report had stated that the concept of collaboration, that is the process in which different professional groups work together, if successfully implemented, will have a positive impact on health care (Zwarenstein, 2009).

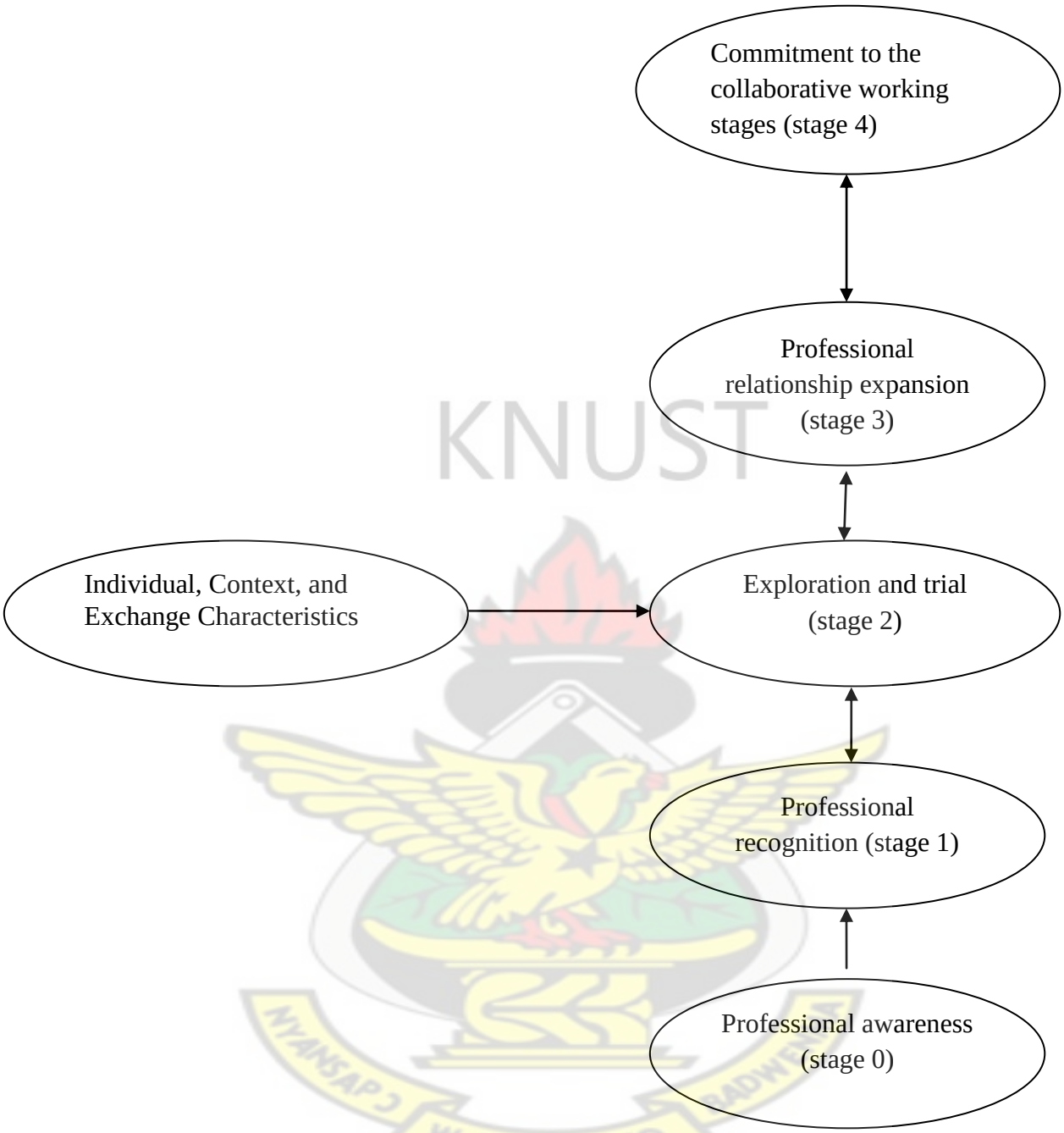


Figure 5.1: The model of CWR designed by McDonough and Doucette adopted from Lui et al (2010)

Doctors in the study were generally comfortable with pharmacists expanding their clinical roles like recommending drug therapies and monitoring effectiveness and side effects of medicines unlike a study done in the largest hospital in Jordan (Tahaineh et al., 2009). In the

Jordan study, they attributed the lack of previous exposure to pharmacists' engagement as their reasons for non-agreement. This fact could explain why in this study junior doctors were more likely to disagree with pharmacists' clinical roles. In addition, the frequent change in where junior doctors work made it difficult to build professional relationships. The findings of this study, interestingly, compares with another study investigating the opinions of doctors and pharmacists toward pharmacists' professional duties; the results showed that over 80% of the sampled participants agreed that pharmacists should have an input in the patient's pharmacotherapeutic plan (Muijrers et al., 2003).

As in the study by Gillespie and colleagues (2012), results of this study showed that the nurses saw the pharmacists as knowledgeable and informative and that they would like to continue the collaboration in the future. They also agreed with the expanded clinical roles of pharmacists but disagreed that pharmacists engaged in any aspects of prescribing as with doctors. All nurses as well as doctors, believed that their collaboration with pharmacists had resulted in enhanced patient care outcomes. Differences were noted in the support of nurses for pharmacists' medication safety activities. As much as 80% wanted pharmacists to provide medication education to patients on admission whiles just above 60% approved pharmacists provision of discharge counselling. It is a possibility that some nurses might have confused the latter role with the general discharge counselling they performed which included patients' medications and might be protecting their territory. It was expected that nurses would have had more collaboration with pharmacists since their residence time at a unit was much stable (Gillespie et al., 2012). Pharmacists need to forge trusting and close relationships when working in a team on a daily basis as this was favourable for inter-professional collaboration (McDonough and Doucette, 2001). On the wards, pharmacists have the opportunity to talk to patients in addressing medication concerns in the presence of nurses. This should further enhance confidence and acceptability by nurses (Kucukarslan et al., 2011).

Nurses in the study did not perceive reconstitution of medicines as a responsibility of pharmacists. Traditionally in Ghana, with the exception of oncology drugs, nurses were solely responsible for reconstitution of parenteral medicines. Studies have described the challenges associated with nurses performing this activity (Wilkinson, 1996, Westbrook et al., 2011, Taxis and Barber, 2004) and hence proper awareness creation will be required for nurses to cede this role to pharmacists who by their training are more skilled (Chedoe et al., 2007, Franklin et al., 2009).

Doctors and nurses had high future expectations of pharmacists. With the exception of one, overwhelming proportions (90%) of respondents expect pharmacists to play more clinical roles in the future. They expressed indifference to the fact that pharmacists should use their knowledge and skills to alter drug regimens to the best interest of patients. Some doctors commented that pharmacists could undertake that activity with their express permission.

5.6 Study Limitations

To be ethically responsible to patients, observers intervened to prevent potentially fatal errors from reaching patients. This might have created awareness and resulted in underestimation of errors. Medicine administrations by non-nursing staff were also not observed during this study. This could have underestimated the total opportunities of errors in the department. However, it was observed that this happened only on very few times when physicians had to administer emergency drugs at the reception of the department.

The convenience sampling used in the national survey may have introduced selection bias though each region of the country was covered (Loewen et al., 2010). The locations of the workplace of participants were only known during the data entry stage. It could be possible that only pharmacists who were enthusiastic about their jobs filled the questionnaire (Oparah and Eferakeya, 2005). The questionnaire contained mostly closed-ended questions and did not include a mix of positively and negatively worded questions, which may have caused some acquiescent response bias (Tahaineh et al., 2009). In attempt to limit bias, the questionnaire was piloted before the study. The data on time spent by participants were self-reports and this might have resulted in overestimation. Future studies should find ways of recording the actual time spent by pharmacists on medication safety activities. This could be achieved by asking respondents to keep daily records of their activities over the study period. This study was a cross-sectional study and hence could not obtain such data.

Chapter 6

6 Conclusion, recommendations and policy implications

6.1 Conclusion

The study was focussed on determining the existence of medication-related problems in hospitals and to explore the evidence of pharmacists' involvement in enhancing medication safety.

The study found that medication administration errors occurred frequently. Majority of the errors were not potentially fatal, but they were clinical significant and could potentially harm patients. In addition to the already established error producing factors such as overcrowding, understaffing, common use of verbal drug orders, frequent interruptions and incomplete patient information, drug supply challenges contributed to the errors.

Pharmacists indicated that they were involved in medication safety activities in their daily routine and spent a greater proportion of their working hours on activities that they believed could result in a greater impact on patient care. The pharmacists mentioned clinical interventions such as identification and prevention of adverse drug events. There were also evidences that pharmacists identified and prevented potential adverse drug events from reaching patients. However, perceived barriers to these medication safety activities related to some attitudes of colleague doctors and nurses. This notwithstanding doctors and nurses expected pharmacists to expand their clinical roles to support patient care in the hospital. They expected pharmacists to provide more medication information to inpatients, assist in selecting cost effective and appropriate drug therapies and take responsibility for resolving drug related problems.

6.2 Policy Implication and Recommendations

This study has shown that there is the need for health systems to prioritise patient safety activities through collaborative efforts. The involvement of pharmacists in enhancing medication safety is akin to many recent automated systems such as CPOE, bar coding and automated dispensing systems. However, resource constraint systems in developing countries would benefit from their pharmacists as a result of the prohibitive cost associated with implementing the technological systems. Knowledge of the contributory factors to medication administration errors should assist healthcare managers in formulating medication safety strategies in their hospitals. The number of patients under nurse's care should be properly assessed to ensure that nurses are not overburdened. Majority of the omission errors

were due to unavailability of medication and this may be due to the inefficiencies in the drug supply system. Strengthening the capacities of practitioners in medicines management will benefit drug supply systems.

The Ministry of Health of Ghana has a crucial role in facilitating the scope of clinical services provided by pharmacists to patients in hospitals. This can be achieved by enhancing clinical pharmacy services in hospitals, and by activating the job description of hospital pharmacy to include these roles. Pharmacy education should become more patient orientated, and the PharmD degree programme that has started in Kwame Nkrumah University of Science and Technology should be mandatory in all pharmacy schools in order to prepare new pharmacy professionals for prominence in pharmacotherapy, delivery of clinical services and formulary management. Institutions mandated to regulate pharmacy practice should demand from practitioners to upgrade their clinical knowledge regularly as requirement for professional license renewal. Efforts should be made to address the negative attitudes towards pharmacists. Training of healthcare staff (doctors, pharmacists and nurses) should therefore be tailored at enhancing collaborative working relationships among them. This cooperation among staff can further be enhanced with continuous professional interactions promoted by policy makers.

6.5 Future Work

In further studies, new approaches should be employed which will afford observers an opportunity to independently observe while being ethically responsible to patients. Medicine administrations by non-nursing staff were not observed during this study. This could have underestimated the total opportunities of errors in the department. However, it was observed that this happened only on very few times when physicians had to administer emergency drugs at the reception of the department. Future studies would benefit from observing all staff involve in medication administration in the hospital.

The basic idea behind pharmacists as a medication safety strategy, using views of pharmacists with questionnaires and collecting retrospective cross sectional information directly from clinical practice has more possibilities than the ones described in this thesis.

This thesis has highlighted the existence of errors in the medication use process and the important role of pharmacists in enhancing medication safety. However, it will be useful to provide more evidence of the use of pharmacists in developing countries. This study was unable to follow-up pharmacists' clinical services to determine the outcomes of the interventions performed. By collecting longitudinal data, it is possible to gather time related data concerning specific pharmacy services that enhances medication safety. Further research has to be done in order to determine specific pharmacy activities with the greatest impact on patient care. The actual cost savings to the health system could also be useful for police makers to support the adoption of this safety strategy.

References

ACHEAMPONG, F., ANTO, B. P. & KOFFUOR, G. A. 2014. Medication safety strategies in hospitals--a systematic review. *Int J Risk Saf Med,* 26**,** 117-31.

AGALU, A., AYELE, Y., BEDADA, W. & WOLDIE, M. 2012. Medication administration errors in an intensive care unit in Ethiopia. *Int Arch Med,* 5**,** 15.

AHRQ. 2010. *Agency for Healthcare Research and Quality* [Online]. Rockville, MD: Agency for Healthcare Research and Quality. Available: http://www.ahrq.gov [Accessed December 2013].

AL RAHBI, H. A. M., AL-SABRI, R. M. & CHITME, H. R. 2014. Interventions by pharmacists in out-patient pharmaceutical care. *Saudi Pharmaceutical Journal,* 22**,** 101-106.

AL-JERAISY, M. I., ALANAZI, M. Q. & ABOLFOTOUH, M. A. 2011. Medication prescribing errors in a pediatric inpatient tertiary care setting in Saudi Arabia. *BMC research notes,* 4**,** 294.

ALJADHEY, H., ALHUSAN, A., ALBURIKAN, K., ADAM, M., MURRAY, M. D. & BATES, D. W. 2013. Medication safety practices in hospitals: A national survey in Saudi Arabia. *Saudi Pharm J,* 21**,** 159-64.

ALJBOURI, T. M., ALKHAWALDEH, M. S., HASAN, T. A., KHATTAR, H. M. & ABU-OLIEM, A. S. 2012. Impact of clinical pharmacist on cost of drug therapy in the ICU. *Saudi Pharmaceutical Journal*.

ALLAN, B. L. 1987. Calculating medication error rates. *Am J Hosp Pharm,* 44**,** 1044-1046.

ALLAN, E. L. & BARKER, K. N. 1990. Fundamentals of medication error research. *Am J Hosp Pharm,* 47**,** 555-571.

AMMENWERTH, E., SCHNELL-INDERST, P., MACHAN, C. & SIEBERT, U. 2008a. The effect of electronic prescribing on medication errors and adverse drug events: a systematic review. *J Am Med Inform Assoc,* 15**,** 585-600.

AMMENWERTH, E., SCHNELL-INDERST, P., MACHAN, C. & SIEBERT, U. 2008b. The effect of electronic prescribing on medication errors and adverse drug events: a systematic review. *J Am Med Inform Assoc,* 15**,** 585-600.

ANEJA, S., BAJAJ, G. & MEHANDIRATTA, S. K. 1992. Errors in medication in a pediatric ward. *Indian pediatrics,* 29**,** 727-730.

APSF. 1988. *Australian Patient Safety Foundation* [Online]. Adelaide: Australian Patient Safety Foundation Inc. Available: http://www.apsf.net.au [Accessed December 2013].

ARMITAGE, G. 2009. Human error theory: relevance to nurse management. *J Nurs Manag,* 17**,** 193-202.

ARMITAGE, G. & KNAPMAN, H. 2003. Adverse events in drug administration: a literature review. *Journal of nursing management,* 11**,** 130-140.

ARMUTLU, M., FOLEY, M.-L., SURETTE, J., BELZILE, E. & MCCUSKER, J. 2008. Survey of nursing perceptions of medication administration practices, perceived sources of errors and reporting behaviours. *Healthcare Quarterly,* 11.

ARONSON, J. K. 2009. Medication errors: definitions and classification. *British journal of clinical pharmacology,* 67**,** 599-604.

ARONSON, J. K. & FERNER, R. E. 2005. Clarification of terminology in drug safety. *Drug safety,* 28**,** 851-870.

ARRIETA, E. E., SUÁREZ-BEREA, M., RODRIGUEZ-JATO, T., CAMPANO, L., RODRIGUEZ, B., TOURIS, M., GONZALEZ, J., MOSQUERA, A., SUÁREZ-RODRIGUEZ, A. & MARTÍNEZ-BAHAMONDE, F. 2012. Evaluation of pharmacist clinical interventions profile in a university hospital. *European Journal of Hospital,* 19**,** 238.

ASH, J. S., SITTING, D. F., POON, E. G., GUAPPONE, K., CAMPBELL, E. & DYKSTRA, R. H. 2007. The Extent and Importance of Unintended Consequences Related to Computerized Provider Order Entry. *Journal of the American Medical Informatics Association,* 14**,** 415-424.

ASHCROFT, D. M., QUINLAN, P. & BLENKINSOPP, A. 2005. Prospective study of the incidence, nature and causes of dispensing errors in community pharmacies. *Pharmacoepidemiol Drug Saf,* 14**,** 327-32.

ASHP 1989. American Society of Hospital Pharmacists(ASHP) statement on the pharmacist's clinical role in organized health care settings. . *Am J Hosp Pharm,* 46**,** 2345-2346.

ASHP 1998. ASHP guidelines on the safe use of automated medication storage and distribution devices. *Am J Health-Syst Pharm.,* 55**,** 1403-1407.

ASPDEN, P., WOLCOTT, J., BOOTMAN, J. L. & CRONENWETT, L. R. 2006. *Preventing medication errors: quality chasm series,* National Academies Press.

AUDIT COMMISSION 2001. A spoonful of sugar: Medicine management in NHS Hospitals. London: Audit commission.

AVERY, A. J. & PRINGLE, M. 2005. Extended prescribing by UK nurses and pharmacists: With more evidence and strict safeguards, it could benefit patients. *BMJ: British Medical Journal,* 331**,** 1154.

AZHAR, S., HASSALI, M. A., IBRAHIM, M., IZHAM, M., SALEEM, F. & SIOW YEN, L. 2012. A survey evaluating nurses' perception and expectations towards the role of pharmacist in Pakistan's healthcare system. *Journal of advanced nursing,* 68**,** 199-205.

BAGGS, J. G. & SCHMITT, M. H. 1997. Nurses' and resident physicians' perceptions of the process of collaboration in an MICU. *Research in nursing & health,* 20**,** 71-80.

BAILIE, G. R. & ROMEO, B. 1996. New York State primary care physicians' attitudes to community pharmacists' clinical services. *Arch Intern Med,* 156**,** 1437-1441.

BAKER, G. R., NORTON, P. G., FLINTOFT, V., BLAIS, R., BROWN, A., COX, J., ETCHELLS, E., GHALI, W. A., HÉBERT, P. & MAJUMDAR, S. R. 2004. The Canadian Adverse Events Study: the incidence of adverse events among hospital patients in Canada. *Canadian Medical Association Journal,* 170**,** 1678-1686.

BANKART, M. J. G., BAKER, R., RASHID, A., HABIBA, M., BANERJEE, J., HSU, R., CONROY, S., AGARWAL, S. & WILSON, A. 2011. Characteristics of general practices associated with emergency admission rates to hospital: a cross-sectional study. *Emergency Medicine Journal,* 28**,** 558-563.

BARBER, N., RAWLINS, M. & FRANKLIN, B. D. 2003. Reducing prescribing error: competence, control, and culture. *Qual Saf Health Care* 12**,** i29–i32.

BARKER, K. N. 1980. Data collection techniques: Observation. . *American Journal of Hospital Pharmacy,* 37**,** 1235-1243.

BARKER, K. N., FLYNN, E. A. & PEPPER, G. A. 2002a. Observation method of detecting medication errors. *Am J Health Syst Pharm,* 59**,** 2314-6.

BARKER, K. N., FLYNN, E. A., PEPPER, G. A., BATES, D. W. & MIKEAL, R. L. 2002b. Medication errors observed in 36 health care facilities. *Arch Intern Med,* 162**,** 1897-903.

BATES, D. W. 1996. Medication errors. How common are they and what can be done to prevent them? *Drug Saf,* 15**,** 303-10.

BATES, D. W. 2002. Using information technology to screen for adverse drug events. *Am J Health Syst Pharm,* 59**,** 2317-9.

BATES, D. W., BOYLE, D. L., VANDER VLIET, M. B., SCHNEIDER, J. & LEAPE, L. 1995a. Relationship between medication errors and adverse drug events. *J Gen Intern Med,* 10**,** 199-205.

BATES, D. W., CULLEN, D. J., LAIRD, N., PETERSEN, L. A., SMALL, S. D., SERVI, D., LAFFEL, G., SWEITZER, B. J., SHEA, B. F. & HALLISEY, R. 1995b. Incidence of adverse drug events and potential adverse drug events. Implications for prevention. *JAMA,* 274**,** 29-34.

BATES, D. W., CULLEN, D. J., LAIRD, N., PETERSEN, L. A., SMALL, S. D., SERVI, D., LAFFEL, G., SWEITZER, B. J., SHEA, B. F., HALLISEY, R. & ET AL. 1995c. Incidence of adverse drug events and potential adverse drug events. Implications for prevention. ADE Prevention Study Group. *JAMA,* 274**,** 29-34.

BATES, D. W., LARIZGOITIA, I., PRASOPA-PLAIZIER, N. & JHA, A. K. 2009. Global priorities for patient safety research. *Bmj,* 338.

BATES, D. W., LEAPE, L. L. & PETRYCKI, S. 1993. Incidence and preventability of adverse drug events in hospitalized adults. *J Gen Intern Med,* 8**,** 289-94.

BATES, D. W., SPELL, N., CULLEN, D. J., BURDICK, E., LAIRD, N., PETERSEN, L. A., SMALL, S. D., SWEITZER, B. J. & LEAPE, L. L. 1997. The costs of adverse drug events in hospitalized patients. Adverse Drug Events Prevention Study Group. *JAMA,* 277**,** 307-11.

BATES, D. W., TEICH, J. M., LEE, J., SEGER, D., KUPERMAN, G. J., MA'LUF, N., BOYLE, D. & LEAPE, L. 1999. The Impact of Computerized Physician Order Entry on Medication Error Prevention. *JAMIA,* 6**,** 313-321.

BELLONE, J. M., BARNER, J. C. & LOPEZ, D. A. 2012. Postdischarge interventions by pharmacists and impact on hospital readmission rates. *J Am Pharm Assoc (2003),* 52**,** 358-62.

BEPKO, R. J., JR., MOORE, J. R. & COLEMAN, J. R. 2009. Implementation of a pharmacy automation system (robotics) to ensure medication safety at Norwalk hospital. *Qual Manag Health Care,* 18**,** 103-14.

BERDOT, S., SABATIER, B., GILLAIZEAU, F., CARUBA, T., PROGNON, P. & DURIEUX, P. 2012. Evaluation of drug administration errors in a teaching hospital. *BMC Health Serv Res,* 12**,** 60.

BERGER, R. G. & KICHAK, J. P. 2004. Computerized Physician Order Entry: Helpful or Harmful? *J Am Med Inform Assoc.* , 11**,** 100-103.

BESO, A., FRANKLIN, B. D. & BARBER, N. 2005. The frequency and potential causes of dispensing errors in a hospital pharmacy. *Pharm World Sci,* 27**,** 182-90.

BETTCHER, B. M., GIOVANNETTI, T., KLOBUSICKY, E., WAMBACH, D., EPPIG, J. & LIBON, D. J. 2011. To err is human, to monitor divine: Environmental adaptations reduce everyday errors but do not im-prove monitoring. . *Journal of Clinical and Experimental Neuropsychology,* 33**,** 1049-1058.

BHATT, A. D. 1999. Drug-related problems and adverse drug events: negligence, litigation and prevention. *J Assoc Physicians India,* 47**,** 715-20.

BLANK, F. S., TOBIN, J., MACOMBER, S., JAOUEN, M., DINOIA, M. & VISINTAINER, P. 2011. A "back to basics" approach to reduce ED medication errors. *J Emerg Nurs,* 37**,** 141-7.

BLUML, B. M., MCKENNEY, J. M. & CZIRAKY, M. J. 2000a. Pharmaceutical Care Services and Results in Project Im PACT: Hyperlipidemia. *J Am Pharm Assoc,* 40**,** 157-65.

BLUML, B. M., MCKENNEY, J. M. & CZIRAKY, M. J. 2000b. Pharmaceutical care services and results in project IMPACT: hyperlipidemia. . *J Am Pharm Assoc,* 40**,** 157-165.

BNF 2012. *British National Formulary,* London, Pharmaceutical Press.

BODDY, C. 2001. Pharmacist involvement with warfarin dosing for inpatients. *Pharmacy World and Science,* 23**,** 31-35.

BOGDEN, P. E., ABBOTT, R. D., WILLIAMSON, P., ONOPA, J. K. & KOONTZ, L. M. 1998. Comparing standard care with a physician and pharmacist team approach for uncontrolled hypertension. *Journal of general internal medicine,* 13**,** 740-745.

BOGDEN, P. E., KOONTZ, L. M., WILLIAMSON, P. & ABBOTT, R. D. 1997. The physician and pharmacist team. An effective approach to cholesterol reduction. *J Gen Intern Med,* 12**,** 158-64.

BOHAND, X., SIMON, L., PERRIER, E., MULLOT, H., LEFEUVRE, L. & PLOTTON, C. 2009. Frequency, types, and potential clinical significance of medication-dispensing errors. *Clinics,* 64**,** 11-16.

BOLING, B., MCKIBBEN, M., HINGL, J., WORTH, P. & JACOBS, B. R. 2005. Effectiveness of Computerized Provider Order Entry with Dose Range Checking on Prescribing Errors. *J Patient Saf,* 1**,** 190-194.

BOND, C. A. & RAEHL, C. L. 2006. Clinical pharmacy services, pharmacy staffing, and adverse drug reactions in United States hospitals. *Pharmacotherapy,* 26**,** 735-747.

BOND, C. A. & RAEHL, C. L. 2007a. Clinical and economic outcomes of pharmacist-managed antimicrobial prophylaxis in surgical patients. *Am J Health Syst Pharm.*, 64**,** 1935-1942.

BOND, C. A. & RAEHL, C. L. 2007b. Clinical Pharmacy Services, Pharmacy Staffing, and Hospital Mortality Rates. *Pharmacotherapy*, 27**,** 481-493.

BOND, C. A. & RAEHL, C. L. 2008. 2006 national clinical pharmacy services survey: clinical pharmacy services, collaborative drug management, medication errors, and pharmacy technology. *Pharmacotherapy,* 28**,** 1-13.

BOND, C. A., RAEHL, C. L. & FRANKE, T. 2001. Interrelationships among mortality rates, drug costs, total cost of care, and length of stay in United States hospitals: summary and recommendations for clinical pharmacy services and staffing. *Pharmacotherapy*, 21**,** 129-41.

BOND, C. A., RAEHL, C. L. & FRANKE, T. 2002. Clinical pharmacy services, hospital pharmacy staffing, and medication errors in United States hospitals. *Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy*, 22**,** 134-147.

BOND, C. A., RAEHL, C. L. & FRANKE, T. 1999. Clinical pharmacy services, pharmacist staffing, and drug costs in united states hospitals. *Pharmacotherapy,* 19**,** 1354-1362.

BOOCKVAR, K. S., CARLSON LACORTE, H., GIAMBANCO, V., FRIDMAN, B. & SIU, A. 2006. Medication reconciliation for reducing drug-discrepancy adverse events. *Am J Geriatr Pharmacother*, 4**,** 236-43.

BOUDREAU, D. M., CAPOCCIA, K. L. & SULLIVAN, S. D. 2002a. Collaborative care model to improve outcomes in major depression. *Ann Pharmacother,* 36**,** 585-591.

BOUDREAU, D. M., CAPOCCIA, K. L., SULLIVAN, S. D., BLOUGH, D. K., ELLSWORTH, A. J., CLARK, D. L., KATON, W. J., WALKER, E. A. & STEVENS, N. G. 2002b. Collaborative care model to improve outcomes in major depression. *Annals of Pharmacotherapy*, 36**,** 585-591.

BOURGEOIS, F. T., MANDL, K. D., VALIM, C. & SHANNON, M. W. 2009. Pediatric adverse drug events in the outpatient setting: an 11-year national analysis. *Pediatrics*, 124**,** e744-50.

BOURNE, R. S. & DORWARD, B. J. 2011a. Clinical pharmacist interventions on a UK neurosurgical critical care unit: a 2-week service evaluation. *Int J Clin Pharm* 33**,** 755-758.

BOURNE, R. S. & DORWARD, B. J. 2011b. Clinical pharmacist interventions on a UK neurosurgical critical care unit: a 2-week service evaluation. *Int J Clin Pharm,* 33**,** 755-8.

BRADSHAW, S. J. & DOUCETTE, W. R. 1997. Community pharmacists as patient advocates: physician attitudes. *Journal of the American Pharmaceutical Association (Washington, DC: 1996),* 38**,** 598-602.

BRADY, A. M., MALONE, A. M. & FLEMING, S. 2009. A literature review of the individual and systems factors that contribute to medication errors in nursing practice. *J Nurs Manage,* 17**,** 679-697.

BRAUN, V. & CLARKE, V. 2006. Using Thematic Analysis in Psychology. *Qualitative Research in Psychology* 3**,** 77-101.

BRENNAN, T. A., GAWANDE, A., THOMAS, E. & STUDDERT, D. 2005. Accidental deaths, saved lives, and improved quality. . *N Engl J Med,* 353**,** 1405-1409.

BRENNAN, T. A., LEAPE, L. L., LAIRD, N. M., HEBERT, L., LOCALIO, A. R., LAWTHERS, A. G., NEWHOUSE, J. P., WEILER, P. C. & HIATT, H. H. 1991. Incidence of adverse events and negligence in hospitalized patients. Results of the Harvard Medical Practice Study I. *N Engl J Med,* 324**,** 370-6.

BROWN, M. 2005. Medication safety issues in the emergency department. *Crit Care Nurs Clin North Am,* 17**,** 65-9, xi.

BUCKLEY, M. S., ERSTAD, B. L., KOPP, B. J., THEODOROU, A. A. & PRIESTLEY, G. 2007. Direct observation approach for detecting medication errors and adverse drug events in a pediatric intensive care unit. *Pediatr Crit Care Med,* 8**,** 145-52.

BUDNITZ, D. S., POLLOCK, D. A., WEIDENBACH, K. N., MENDELSOHN, A. B., SCHROEDER, T. J. & ANNEST, J. L. 2006. National surveillance of emergency department visits for outpatient adverse drug events. *JAMA,* 296**,** 1858-66.

BURSTIN, H. 2002. "Crossing the quality chasm" in emergency medicine. *Acad Emerg Med,* 9**,** 1074-1077.

BUTLER, C. C., ROLLNICK, S., PILL, R., MAGGS-RAPPORT, F. & STOTT, N. 1998. *Understanding the culture of prescribing: qualitative study of general practitioners' and patients' perceptions of antibiotics for sore throats*.

BUURMA, H., DE SMET, P. A. G. M., LEUFKENS, H. G. M. & EGBERTS, A. C. G. 2004. Evaluation of the clinical value of pharmacists' modifications of prescription errors. *British journal of clinical pharmacology,* 58**,** 503-511.

CAMPBELL, T. & LUNN, D. 1997. Intravenous therapy: current practice and nursing concerns. *Br J Nurs,* 6**,** 1218-1228.

CANADA, A. 2012. *Required Organizational Practices 2012* [Online]. Ottawa, Ontario, Canada: Accreditation Canada. Available: http://www.accreditation.ca/uploadedFiles/ROP Handbook.pdf [Accessed February 2014].

CARE, A. C. F. S. A. Q. I. H. 2002. Second National Report on Patient Safety: Improving Medication Safety. Canberra: Australian Council for Safety and Quality in Health Care.

CAREY, R. G. & SEIBERT, J. H. 1993. A patient survey system to measure quality improvement: questionnaire reliability and validity. *Medical care***,** 834-845.

CHEDOE, I., MOLENDIJK, H. A., DITTRICH, S. T., JANSMAN, F. G., HARTING, J. W., BROUWERS, J. R. & TAXIS, K. 2007. Incidence and nature of medication errors in neonatal intensive care with strategies to improve safety: a review of the current literature. *Drug Saf,* 30**,** 503-13.

CHRISTEN, C. 2006. Clinical pharmacy and medication safety. *Ann Pharmacother,* 40**,** 2020-1.

CHUA, S. S., CHUA, H. M. & OMAR, A. 2010. Drug administration errors in paediatric wards: a direct observation approach. *Eur J Pediatr*, 169**,** 603-11.

CLASSEN, D. C., PESTOTNIK, S. L., EVANS, R. S. & BURKE, J. P. 2005. Computerized surveillance of adverse drug events in hospital patients. . *Quality & Safety in Health Care,* 14**,** 221-225.

CLASSEN, D. C., PESTOTNIK, S. L., EVANS, R. S., LLOYD, J. F. & BURKE, J. P. 1997. Adverse drug events in hospitalized patients. Excess length of stay, extra costs, and attributable mortality. *JAMA*, 277**,** 301-6.

COAST-SENIOR, E. A., KRONER, B. A., KELLEY, C. L. & TRILLI, L. E. 1998. Management of patients with type 2 diabetes by pharmacists in primary care clinics. *Annals of Pharmacotherapy,* 32**,** 636-641.

COBAUGH, D. J. & SCHNEIDER, S. M. 2005. Medication use in the emergency department: why are we placing patients at risk? . *Am J Health Syst Pharm,* 62**,** 1832-1833.

COHEN, J. 1988. *Statistical power analysis for the behavioral sciences,* Hillsdale (NJ), Erlbaum.

COHEN, M. M., KIMMEL, N. L., BENAGE, M. K., COX, M. J., SANDERS, N., SPENCE, D. & CHEN, J. 2005. Medication safety program reduces adverse drug events in a community hospital. *Qual Saf Health Care,* 14**,** 169-74.

COLEMAN, E. A., SMITH, J. D., RAHA, D. & MIN, S. J. 2005. Posthospital medication discrepancies: prevalence and contributing factors. . *Arch Intern Med,* 165**,** 1842-1847.

COMMISSION, H. Q. S. 2012. *National Patient Safety Campaign* [Online]. Wellington, New Zealand: Health Quality & Safety Commission. Available: http://www.hqsc.govt.nz/ [Accessed December 2013].

COMMISSION, J. 1951. The Joint Commission. USA: Joint Commission.

COOMBES, I. D., REID, C., MCDOUGALL, D., STOWASSER, D., DUIGUID, M. & MITCHELL, C. 2011. Pilot of a National Inpatient Medication Chart in Australia: improving prescribing safety and enabling prescribing training. *Br J Clin Pharmacol,* 72**,** 338-49.

CORNU, P., STEURBAUT, S., ŠOŠTARIĆ, S., MRHAR, A. & DUPONT, A. 2014. Performance of a clinical decision support system and of clinical pharmacists in preventing drug–drug interactions on a geriatric ward. *International Journal of Clinical Pharmacy***,** 1-7.

COSTA, L. A., VALLI, C. & ALVARENGA, A. P. 2008. Medication dispensing errors at a public pediatric hospital. *Rev Lat Am Enfermagem,* 16**,** 812-7.

COWLEY, E. 2000. Assessing and preventing medication errors in home care. *Home healthcare Consultant,* 7**,** 33-40.

CULLEN, D. J., BATES, D. W., SMALL, S. D., COOPER, J. B., NEMESKAL, A. R. & LEAPE, L. L. 1995. The incident reporting system does not detect adverse drug events: a problem for quality improvement. *Jt Comm J Qual Improv,* 21**,** 541-8.

CULLEN, D. J., SWEITZER, B. J., BATES, D. W., BURDICK, E., EDMONDSON, A. & LEAPE, L. L. 1997. Preventable adverse drug events in hospitalized patients: a comparative study of intensive care and general care units. *Crit Care Med,* 25**,** 1289-97.

CUNNINGHAM, K. J. 2012. Analysis of Clinical Interventions and the Impact of Pediatric Pharmacists on Medication Error Prevention in a Teaching Hospital. *J Pediatr Pharmacol Ther,* 17**,** 365-373.

CUNNINGHAM, T. R., GELLER, E. S. & CLARKE, S. W. 2008. Impact of electronic prescribing in a hospital setting: A process-focused evaluation

. *international journal of medical informatics,* 77**,** 546-554.

DASHTI-KHAVIDAKI, S., KHALILI, H., HAMISHEKAR, H. & SHAHVERDI, S. 2009. Clinical pharmacy services in an Iranian teaching hospital: a descriptive study. *Pharm World Sci,* 31**,** 696-700.

DAVEY, A. L., BRITLAND, A. & NAYLOR, R. J. 2008. Decreasing paediatric prescribing errors in a district general hospital. *Qual Saf Health Care,* 17**,** 146–149.

DAVIS, P. B., LAY-YEE, R., BRIANT, R. H., ALI, W., SCOTT, A. J. & SCHUG, S. 2002. Adverse events in New Zealand public hospitals I: occurrence and impact.

DAVYDOV, LIYA, CALIENDO, GINA, C., SMITH, LAWRENCE, G., MEHL & BERNARD 2003. *Analysis of clinical intervention documentation by dispensing pharmacists in a teaching hospital,* St. Louis, MO, ETATS-UNIS, Thomas Land.

DE VRIES, E. N., RAMRATTAN, M. A., SMORENBURG, S. M., GOUMA, D. J. & BOERMEESTER, M. A. 2008. The incidence and nature of in-hospital adverse events: a systematic review. . *Quality & Safety in Health Care* 17**,** 216-223.

DEAN, B. 1999. Errors in medication administration. *Intensive Care Med,* 25**,** 341-2.

DEAN, B. 2002. Learning from prescribing errors. *Qual Saf Health Care,* 11**,** 258-60.

DEAN, B. & BARBER, N. 2001. Validity and reliability of observational methods for studying medication administration errors. . *Am J Health Syst Pharm,* 58**,** 54-59.

DEAN, B., BARBER, N. & SCHACHTER, M. 2000. What is a prescribing error? *Qual Health Care,* 9**,** 232-7.

DEAN, B., SCHACHTER, M., VINCENT, C. & BARBER, N. 2002a. Causes of prescribing errors in hospital inpatients: a prospective study. *Lancet,* 359**,** 1373-8.

DEAN, B., SCHACHTER, M., VINCENT, C. & BARBER, N. 2002b. Prescribing errors in hospital inpatients: their incidence and clinical significance. *Qual Saf Health Care,* 11**,** 340-4.

DEAN, B. S. & BARBER, N. D. 1999. A validated, reliable method of scoring the severity of medication errors. *Am J Health Syst Pharm,* 56**,** 57-62.

DEMAEYER, E. M. 1989. *Preventing and controlling iron defiency anaemia through primary health care: a guide for health administrators and programme managers,* World Health Organization.

DONABEDIAN, A. 1988. The quality of care. How can it be assessed? *JAMA: the journal of the American Medical Association,* 260**,** 1743.

DONAHUE, S. M. & NEEDLEMAN, S. M. 1998. Potential cause for medication administration error. *Anesthesiology,* 89**,** 800-1.

DONALDSON, L. 2002. An organisation with a memory. *Clinical Medicine,* 2**,** 452-457.

DONALDSON, L. J. & FLETCHER, M. G. 2006. The WHO World Alliance for Patient Safety: towards the years of living less dangerously. *Medical Journal of Australia,* 184**,** S69.

DRANITSARIS, G., SPIZZIRRI, D., PITRE, M. & MCGEER, A. 2001. A randomized trial to measure the optimal role of the pharmacist in promoting evidence-based antibiotic use in acute care hospitals. *International journal of technology assessment in health care,* 17**,** 171-180.

DUSSART, C., DUSSART, S., ALMERAS, D., CAMAL, I. & GRELAUD, G. 2009. Assessing user satisfaction and hospital pharmacy practice: application to an individualized dispensing system in a French military teaching hospital. *J Eval Clin Pract,* 15**,** 252-6.

ELLIS, R. F., STEPHENS, M. A. & SHARP, G. B. 1992. Evaluation of a pharmacy-managed warfarin-monitoring service to coordinate inpatient and outpatient therapy. *American Journal of Health-System Pharmacy,* 49**,** 387-394.

FACCHINETTI, N. J., CAMPBELL, G. M. & JONES, D. P. 1999. Evaluating dispensing error detection rates in a hospital pharmacy. *Med Care,* 37**,** 39-43.

FARBSTEIN, K. & CLOUGH, J. 2001. Improving medication safety across a multihospital system. *Jt Comm J Qual Improv,* 27**,** 123-37.

FERNÁNDEZ-LLAMAZARES, C. M., CALLEJA-HERNANDEZ, M. A., MANRIQUE-RODRIGUEZ, S., PÉREZ-SANZ, C., DURAN-GARCÍA, E. & SANJURJO-SAEZ, M. 2012. Impact of clinical pharmacist interventions in reducing paediatric prescribing errors. *Arch Dis Child,* 97**,** 564-568.

FERNANDEZ-LLAMAZARES, C. M., POZAS, M., FEAL, B., CABANAS, M. J., VILLARONGA, M., HERNANDEZ-GAGO, Y., RUIZ DE VILLEGAS, M. & ALVAREZ-DEL-VAYO, C. 2013. Profile of prescribing errors detected by clinical pharmacists in paediatric hospitals in Spain. *Int J Clin Pharm,* 35**,** 638-46.

FERNER, R. E. 2009. The epidemiology of medication errors: the methodological difficulties. *British journal of clinical pharmacology,* 67**,** 614-620.

FIELD, T. S., GURWITZ, J. H., HARROLD, L. R., ROTHSCHILD, J. M., DEBELLIS, K., SEGER, A. C., FISH, L. S., GARBER, L., KELLEHER, M. & BATES, D. W. 2004. Strategies for detecting adverse drug events among older persons in the ambulatory setting. *J Am Med Inform Assoc,* 11**,** 492-8.

FITZHENRY, F., PETERSON, J. F., ARRIETA, M., WAITMAN, L. R., SCHILDCROUT, J. S. & MILLER, R. A. 2007. Medication Administration Discrepancies Persist Despite Electronic Ordering. *J Am Med Inform Assoc.,* 14**,** 756-764.

FLEISS, J. L., LEVIN, B. & PAIK, M. C. 1981. The measurement of interrater agreement. *Statistical methods for rates and proportions,* 2**,** 212-236.

FLYNN, E. A., BARKER, K. & BARKER, B. 2010. Medication-administration errors in an emergency department. *Am J Health Syst Pharm,* 67**,** 347-8.

FLYNN, E. A., BARKER, K. N., PEPPER, G. A., BATES, D. W. & MIKEAL, R. L. 2002. Comparison of methods for detecting medication errors in 36 hospitals and skilled-nursing facilities. *Am J Health Syst Pharm,* 59**,** 436-46.

FOLLI, H., POOLE, R. L., BENITZ, W. & RUSSO, J. C. 1987. Medication Error Prevention by Clinical Pharmacists in Two Children's Hospitals. *Pediatrics,* 79**,** 718-722.

FOOTE, S. O. & COLEMAN, J. R. 2008. Medication administration: the implementation process of bar-coding for medication administration to enhance medication safety. *Nurs Econ,* 26**,** 207-10.

FOWLIE, F., BENNIW, M. & JARDINE, G. 2000. Evaluation of an electronic prescribing and administration system in a British hospital. *Pharm J* 265**,** 7114.

FRANKLIN, B. D., O'GRADY, K., DONYAI, P., JACKLIN, A. & BARBER, N. 2007. The impact of a closed-loop electronic prescribing and administration system on prescribing errors, administration errors and staff time: a before-and-after study. *Qual Saf Health Care,* 16**,** 279-84.

FRANKLIN, B. D., REYNOLDS, M., SHEBL, N. A., BURNETT, S. & JACKLIN, A. 2011. Prescribing errors in hospital inpatients: a three-centre study of their prevalence, types and causes. *Postgrad Med J,* 87**,** 739-45.

FRANKLIN, B. D., ROSA, M. B., MILLER, G. & JACKLIN, A. 2012a. The evaluation of a novel model of providing ward pharmacy services. *Int J Clin Pharm,* 34**,** 518-523.

FRANKLIN, B. D., ROSA, M. B., MILLER, G. & JACKLIN, A. 2012b. The evaluation of a novel model of providing ward pharmacy services. *Int J Clin Pharm,* 34**,** 518-23.

FRANKLIN, B. D., TAXIS, K. & BARBER, N. 2009. Parenteral drug errors. Reported error rates are likely to be underestimation. *BMJ,* 338**,** b1814.

FRANKLIN, B. D., VINCENT, C., SCHACHTER, M. & BARBER, N. 2005. The incidence of prescribing errors in hospital inpatients. *Drug Safety,* 28**,** 891-900.

FREEMAN, R., MCKEE, S., LEE-LEHNER, B. & PESENECKER, J. 2013. Reducing interruptions to improve medication safety. *J Nurs Care Qual,* 28**,** 176-85.

GALANTER, W. L., HIER, D. B., JAO, C. & SARNEA, D. 2010. Computerized physician order entry of medications and clinical decision support can improve problem list documentation compliance. *international journal of medical informatics,* 79.

GALT, K. A. 1995. The key to pharmacist prescribing: collaboration. *American journal of health-system pharmacy,* 52**,** 1696-1699.

GANDHI, T. K., WEINGART, S. N., BORUS, J., SEGER, A. C., PETERSON, J., BURDICK, E., SEGER, D. L., SHU, K., FEDERICO, F., LEAPE, L. L. & BATES, D. W. 2003. Adverse drug events in ambulatory care. *N Engl J Med,* 348**,** 1556-64.

GARABEDIAN-RUFFALO, S. M., GRAY, D. R., SAX, M. J. & RUFFALO, R. L. 1985. Retrospective evaluation of a pharmacist-managed warfarin anticoagulation clinic. *American Journal of Health-System Pharmacy,* 42**,** 304-308.

GAWANDE, A. A., ZINNER, M. J., STUDDERT, D. M. & BRENNAN, T. A. 2003. Analysis of Errors Reported by Surgeons at Three Teaching Hospitals. *Surgery,* 133**,** 614-621.

GHALEB, M. A., BARBER, N., FRANKLIN, B. D. & WONG, I. C. 2010. The incidence and nature of prescribing and medication administration errors in paediatric inpatients. *Arch Dis Child,* 95**,** 113-8.

GILLESPIE, U., MO¨RLIN, C., HAMMARLUND-UDENAES, M. & HEDSTRO¨M, M. 2012. Perceived value of ward-based pharmacists from the perspective of physicians and nurses. *Int J Clin Pharm* 34**,** 127–135.

GINZBURG, R., BARR , W. B., HARRIS, M. & MUNSHI, S. 2009. Effect of a weight-based prescribing method within an electronic health record on prescribing errors. *Am J Health-Syst Pharm. ,* 66**,** 2037-2041.

GOLDMANN, D. & KAUSHAL, R. 2002. Time to tackle the tough issues in patient safety. *Pediatrics,* 110**,** 823-826.

GONZALES, K. 2010. Medication Administration Errors and the Pediatric Population: A Systematic Search of the Literature. *Journal of Pediatric Nursing* 25**,** 555-565.

GREENGOLD, N. L., SHANE, R., SCHNEIDER, P., FLYNN, E., ELASHOFF, J., HOYING, C. L., BARKER, K. & BOLTON, L. B. 2003. The impact of dedicated medication nurses on the medication administration error rate: a randomized controlled trial. *Arch Intern Med,* 163**,** 2359-67.

GUEST, G. & BUNCE, A. 2006. How Many Interviews Are Enough? An Experiment with Data Saturation and Variability. *Field Methods,* 18**,** 59-82.

GURWITZ, J. H., FIELD, T. S., AVORN, J., MCCORMICK, D., JAIN, S., ECKLER, M., BENSER, M., EDMONDSON, A. C. & BATES, D. W. 2000. Incidence and preventability of adverse drug events in nursing homes. *Am J Med,* 109**,** 87-94.

GURWITZ, J. H., FIELD, T. S., RADFORD, M. J., HARROLD, L. R., BECKER, R., REED, G., DEBELLIS, K., MOLDOFF, J. & VERZIER, N. 2007. The safety of warfarin therapy in the nursing home setting. *The American journal of medicine,* 120**,** 539-544.

HALLGREN, J., TENGVALL-LINDER, M., PERSSON, M. & WAHLGREN, C. F. 2003. Stevens-Johnson syndrome associated with ciprofloxacin: a review of adverse cutaneous events reported in Sweden as associated with this drug. *J Am Acad Dermatol,* 49**,** S267-9.

HANLON, J. T., WEINBERGER, M., SAMSA, G. P., SCHMADER, K. E., UTTECH, K. M., LEWIS, I. K., COWPER, P. A., LANDSMAN, P. B., COHEN, H. J. & FEUSSNER, J. R. 1996. A randomized, controlled trial of a clinical pharmacist intervention to improve inappropriate prescribing in elderly outpatients with polypharmacy. *The American journal of medicine,* 100**,** 428-437.

HANSEN, R. A., GREENE, S. B., WILLIAMS, C. E., BLALOCK, S. J., CROOK, K. D., AKERS, R. & CAREY, T. S. 2006. Types of medication errors in North Carolina nursing homes: a target for quality improvement. *The American journal of geriatric pharmacotherapy,* 4**,** 52-61.

HARRISON, B. T., GIBBERD, R. W., HAMILTON, J. D. & WILSON, R. M. 1999. An analysis of the causes of adverse events from the Quality in Australian Health Care Study. *Med J Aust,* 170**,** 411-415.

HARTWIG, S. C., DENGER, S. D. & SCHNEIDER, P. J. 1991. Severity-indexed, incident report-based medication error-reporting program. *American Journal of Health-System Pharmacy,* 48**,** 2611-2616.

HASSAN, E., BADAWI, O., WEBER, R. J. & COHEN, H. 2010a. Using technology to prevent adverse drug events in the intensive care unit. *Crit Care Med,* 38**,** S97-S105.

HASSAN, Y., AL-RAMAHI, R. J., AZIZ, N. A. & GHAZALI, R. 2010b. Adverse drug events in hospitalized patients with chronic kidney disease. *Int J Clin Pharmacol Ther,* 48**,** 571-6.

HAW, C., STUBBS, J. & DICKENS, G. 2007. An observational study of medication administration errors in old-age psychiatric inpatients. *International Journal for Quality in Health Care,* 19**,** 210-216.

HEPLER, C. D. & STRAND, L. M. 1990. Opportunities and responsibilities in pharmaceutical care. *Am J Hosp Pharm,* 47**,** 533-43.

HO, L., AKADA, K., MESSNER, H., KURUVILLA, J., WRIGHT, J. & SEKI, J. T. 2013. Pharmacist's Role in Improving Medication Safety for Patients in an Allogeneic Hematopoietic Cell Transplant Ambulatory Clinic. *Can J Hosp Pharm,* 66**,** 110-7.

HOEFEL, H. H., LAUTERT, L. & SCHMITT, C. 2008. Vancomycin administration:mistakes made by nursing staff. *Nurs Stand,* 22**,** 35-42.

HUG, B. L., WITKOWSKI, D. J., SOX, C. M., KEOHANE, C. A., SEGER, D. L. & YOON, C. 2010. Adverse drug event rates in six community hospitals and the potential impact of computerized physician order entry for prevention. *J Gen Intern Med* 25**,** 31-38.

HUGHES, C. M. & MCCANN, S. 2003. Perceived interprofessional barriers between community pharmacists and general practitioners: a qualitative assessment. *The British journal of general practice,* 53**,** 600.

IHI. 2013. *Institute of Healthcare Improvement* [Online]. Cambridge, MA. [Accessed December 2013].

ILAN, R. & FOWLER, R. 2005. Brief history of patient safety culture and science. *Journal of Critical Care,* 20**,** 2-5.

IOM, C. O. Q. O. H. C. I. A. A. 2001. Crossing the quality chasm: A new health system for the 21st century. Washington (DC): Committee on Health Care in America. Institute of Medicine.

ISMP 2011. *Adverse Drug Events and Potential Adverse Drug Events,* Horsham, PA, USA, Institute for Safe Medication Practices.

ISMP. 2013. *Institute for Safe Medication Practices* [Online]. Horsham, PA: Institute for Safe Medication Practices. Available: http://www.ismp.org/ [Accessed December 2013].

JHA, A. K., PRASOPA-PLAIZIER, N., LARIZGOITIA, I. & BATES, D. W. 2010. Patient safety research: an overview of the global evidence. *Quality and Safety in Health Care,* 19**,** 42-47.

JOHNSON, J. A., COONS, S. J., HAYS, R. D. & PICKARD, A. S. 1999. Health status and satisfaction with pharmacy services. *The American journal of managed care,* 5**,** 163-170.

JONSSON, P. M. & ØVRETVEIT, J. 2008. Patient claims and complaints data for improving patient safety. *Int J Health Care Qual Assur,* 21**,** 60-74.

JOOSTEN, H., DRION, I., BOOGERD, K. J., VAN DER PIJL, E. V., SLINGERLAND, R. J., SLAETS, J. P., JANSEN, T. J., SCHWANTJE, O., GANS, R. O. & BILO, H. J. 2013. Optimising drug prescribing and dispensing in subjects at risk for drug errors due to renal impairment: improving drug safety in primary healthcare by low eGFR alerts. *BMJ Open,* 3.

JYLHA, V., SARANTO, K. & BATES, D. W. 2011. Preventable adverse drug events and their causes and contributing factors: the analysis of register data. *Int J Qual Health Care,* 23**,** 187-97.

KABOLI, P. J., HOTH, A. B., MCCLIMON, B. J. & SCHNIPPER, J. L. 2006a. Clinical pharmacists and inpatient medical care: a systematic review. *Archives of Internal Medicine,* 166**,** 955.

KABOLI, P. J., HOTH, A. B., MCCLIMON, B. J. & SCHNIPPER, J. L. 2006b. Clinical pharmacists and inpatient medical care: A systematic review. *Arch Intern Med,* 166**,** 955-964.

KAUR, S., MITCHELL, G., VITETTA, L. & ROBERTS, M. 2009a. Interventions that can reduce inappropriate prescribing in the elderly: a systematic review. *Drugs Aging,* 26**,** 1013-1028.

KAUR, S., MITCHELL, G., VITETTA, L. & ROBERTS, M. S. 2009b. Interventions that can reduce inappropriate prescribing in the elderly. *Drugs & aging,* 26**,** 1013-1028.

KAUSHAL, R. 2002. Using chart review to screen for medication errors and adverse drug events. *Am J Health Syst Pharm,* 59**,** 2323-5.

KAUSHAL, R., BATES, D. W., LANDRIGAN, C., MCKENNA, K. J., CLAPP, M. D., FEDERICO, F. & GOLDMANN, D. A. 2001. Medication errors and adverse drug events in pediatric inpatients. *JAMA,* 285**,** 2114-20.

KAUSHAL, R., SHOJANIA, K. G. & BATES, D. W. 2003. Effects of computerized physician order entry and clinical decision support systems on medication safety: a systematic review. *Arch Intern Med,* 163**,** 1409-16.

KAZANDJIAN, V. A., OGUNBO, S., WICKER, K. G., VAIDA, A. J. & PIPESH, F. 2009. Enhancing medication use safety: benefits of learning from your peers. *Qual Saf Health Care,* 18**,** 331-5.

KELLY, J. & WRIGHT, D. 2012. Medicine administration errors and their severity in secondary care older persons' ward: a multi-centre observational study. *Journal of clinical nursing,* 21**,** 1806-1815.

KHUDAIR, I. F. & RAZA, S. A. 2013. Measuring patients' satisfaction with pharmaceutical services at a public hospital in Qatar. *Int J Health Care Qual Assur,* 26**,** 398-419.

KILCUP, M., SCHULTZ, D., CARLSON, J. & WILSON, B. 2013. Postdischarge pharmacist medication reconciliation: impact on readmission rates and financial savings. *J Am Pharm Assoc (2003),* 53**,** 78-84.

KLIBANOV, O. M. & ECKEL, S. F. 2003. Effects of automated dispensing on inventory control, billing, workload, and potential for medication errors. *Am J Health Syst Pharm,* 60**,** 569-72.

KLOPOTOWSKA, J. E., KUIPER, R., VAN KAN, H. J., DE PONT, A.-C., DIJKGRAAF, M. G., LIE-A-HUEN, L., VROOM, M. B. & SMORENBURG, S. M. 2011a. On-ward participation of a hospital pharmacist in a Dutch intensive care unit reduces prescribing errors and related patient harm: an intervention study. *Critical Care,* 14**,** 174-185.

KLOPOTOWSKA, J. E., WIERENGA, P. C., DE ROOIJ, S. E., STUIJT, C. C., ARISZ, L., KUKS, P. F., DIJKGRAAF, M. G., LIE, A. H. L., SMORENBURG, S. M. & GROUP, W. S. 2011b. The effect of an active on-ward participation of hospital pharmacists in Internal Medicine teams on preventable Adverse Drug Events in elderly inpatients: protocol of the WINGS study (Ward-oriented pharmacy in newly admitted geriatric seniors). *BMC Health Serv Res,* 11**,** 124.

KOHN, L. T., CORRIGAN, J. & DONALDSON, M. S. 2000a. *Committee on Quality of Health Care in America, Institute of Medicine. To Err is Human: Building a Safer Health System.,* Washington DC, National Academy Press.

KOHN, L. T., CORRIGAN, J. M. & DONALDSON, M. S. 2000b. *To err is human: building a safer health system,* Washington, DC, National Academy Press.

KOPP, B. J., ERSTAD, B. L., ALLEN, M. E., THEODOROU, A. A. & PRIESTLEY, G. 2006. Medication errors and adverse drug events in an intensive care unit: direct observation approach for detection. *Critical care medicine,* 34**,** 415-425.

KOREN, G., REICH, A. & HALES, B. 1991. Use of clinical pharmacists to prevent medication errors in children. *J Pharm Technol,* 7**,** 219-21.

KRADJAN, W. A., SCHULZ, R., CHRISTENSEN, D. B., STERGACHIS, A., SULLIVAN, S., FULLERTON, D. S., STURM, L. & SCHNEIDER, G. 1998. Patients' perceived benefit from and satisfaction with asthma-related pharmacy services. *Journal of the American Pharmaceutical Association (Washington, DC: 1996),* 39**,** 658-666.

KRELING, D. H., DOUCETTE, W. R., MOTT, D. A., GAITHER, C. A., PEDERSEN, C. A. & SCHOMMER, J. C. 2006. Community pharmacists' work environments: evidence from the 2004 National Pharmacist Workforce Study. *Journal of the American Pharmacists Association: JAPhA,* 46.

KRIPALANI, S., LEFEVRE, F., PHILLIPS, C. O., WILLIAMS, M. V., BASAVIAH, P. & BAKER, D. W. 2007. Deficits in communication and information transfer between hospital-based and primary care physicians: implications for patient safety and continuity of care. *JAMA,* 297**,** 831-841.

KRUPICKA, M. I., BRATTON, S. L., SONNENTHAL, K. & GOLDSTEIN, B. 2002. Impact of a pediatric clinical pharmacist in the pediatric intensive care unit. *Crit Care Med,* 30**,** 919-21.

KUCUKARSLAN, S., LAI, S., DONG, Y., AL-BASSAM, N. & KIM, K. 2011. Physician beliefs and attitudes toward collaboration with community pharmacists. *Research in Social and Administrative Pharmacy* 7**,** 224-232.

KUCUKARSLAN, S. N., PETERS, M., MLYNAREK, M. & NAFZIGER, D. A. 2003. Pharmacists on rounding teams reduce preventable adverse drug events in hospital general medicine units. *Arch Intern Med,* 163**,** 2014-8.

KUO, G. M., PHILLIPS, R. L., GRAHAM, D. & HICKNER, J. M. 2008. Medication errors reported by US family physicians and their office staff. *Quality and Safety in Health Care,* 17**,** 286-290.

KWAN, J. L., LO, L., SAMPSON, M. & SHOJANIA, K. G. 2013. Medication reconciliation during transitions of care as a patient safety strategy: a systematic review. *Ann Intern Med,* 158**,** 397-403.

LAINER, M., MANN, E. & SONNICHSEN, A. 2013. Information technology interventions to improve medication safety in primary care: a systematic review. *Int J Qual Health Care.*

LANGEBRAKE, C. & HILGARTH, H. 2010. Clinical pharmacists' interventions in a German University Hospital. *Pharm World Sci,* 32**,** 194-199.

LATTER, S., BLENKINSOPP, A., SMITH, A., CHAPMAN, S., TINELLI, M., GERARD, K., LITTLE, P., CELINO, N., GRANBY, T. & NICHOLLS, P. 2010. *Evaluation of nurse and pharmacist independent prescribing,* University of Southampton; Keele University.

LAWTON, R., CARRUTHERS, S., GARDNER, P., WRIGHT, J. & MCEACHAN, R. R. C. 2012. Identifying the Latent Failures UnderpinningMedication Administration Errors: An Exploratory Study. *HSR: Health Services Research* 47**,** 1437-1459.

LEAPE, L. L. 2008. Scope of problem and history of patient safety. *Obstetrics and gynecology clinics of North America,* 35**,** 1-10.

LEAPE, L. L., BATES, D. W., CULLEN, D. J., COOPER, J., DEMONACO, H. J., GALLIVAN, T., HALLISEY, R., IVES, J., LAIRD, N., LAFFEL, G. & ET AL. 1995. Systems analysis of adverse drug events. ADE Prevention Study Group. *JAMA,* 274**,** 35-43.

LEAPE, L. L., BRENNAN, T. A., LAIRD, N., LAWTHERS, A. G., LOCALIO, A. R., BARNES, B. A., HEBERT, L., NEWHOUSE, J. P., WEILER, P. C. & HIATT, H. 1991. The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. *N Engl J Med,* 324**,** 377-84.

LEAPE, L. L., CULLEN, D. J., CLAPP, M. D., BURDICK, E., DEMONACO, H. J., ERICKSON, J. I. & BATES, D. W. 1999a. Pharmacist participation on physician rounds and adverse drug events in the intensive care unit. *JAMA,* 282**,** 267-70.

LEAPE, L. L., CULLEN, D. J., CLAPP, M. D., BURDICK, E., DEMONACO, H. J., ERICKSON, J. I. & BATES, D. W. 1999b. Pharmacist Participation on Physician Rounds and Adverse Drug Events in the Intensive Care Units. *JAMA,* 282**,** 267-270.

LESAR, T., BRICELAND, L. & STEIN, D. 1997a. Factors related to errors in medication prescribing. . *Journal of the American Medical Association,,* 277**,** 312-317.

LESAR, T. S. 2002. Prescribing errors involving medication dosage forms. *Journal of general internal medicine,* 17**,** 579-587.

LESAR, T. S., BRICELAND, L. L., DELCOURE, K., PARMALEE, J. C., MASTA-GORNIC, V. & POHL, H. 1990. Medication prescribing errors in a teaching hospital. *JAMA: the journal of the American Medical Association,* 263**,** 2329-2334.

LESAR, T. S., LOMAESTRO, B. M. & POHL, H. 1997b. Medication-prescribing errors in a teaching hospital: a 9-year experience. *Archives of Internal Medicine,* 157**,** 1569.

LEWIS, P. J., DORNAN, T., TAYLOR, D., TULLY, M. P., WASS, V. & ASHCROFT, D. M. 2009. Prevalence, Incidence and Nature of Prescribing Errors in Hospital Inpatients: A Systematic Review. . *Drug Safety,* 32**,** 379-389.

LISBY, M., NIELSEN, L. P., BROCK, B. & MAINZ, J. 2012. How should medication errors be defined? Development and test of a definition. *Scand J Public Health,* 40**,** 203-10.

LIU, Y., DOUCETTE, W. R. & FARRIS, K. B. 2010. Examining the development of pharmacist-physician collaboration over 3 months. *Research in Social and Administrative Pharmacy,* 6**,** 324-333.

LOEWEN, P., MERRETT, F. & DE LEMOS, J. 2010. Pharmacists' perceptions of the impact of care they provide. *Pharmacy Practice,* 8**,** 89-95.

LUKER, K., AUSTIN, L., HOGG, C., FERGUSON, B. & SMITH, K. 1997. Nurse prescribing: the views of nurses and other health care professionals. *British Journal of Community Nursing,* 2**,** 69-74.

LUND, B. C., CARNAHAN, R. M., EGGE, J. A., CHRISCHILLES, E. A. & KABOLI, P. J. 2010. Inappropriate prescribing predicts adverse drug events in older adults. *Ann Pharmacother,* 44**,** 957-63.

MACKINNON, N. J. 2002. Early Warning: How Vigilant Pharmacists Can Prevent Drug-related Morbidity in Seniors. *Pharm. Pract. ,* 18**,** 40-44.

MACLAREN, R., BOND, C. A., MARTIN, S. J. & FIKE, D. 2008. Clinical and economic outcomes of involving pharmacists in the direct care of critically ill patients with infections*. *Critical care medicine,* 36**,** 3184-3189.

MACLAREN, R., DEVLIN, J. W., MARTIN, S. J., DASTA, J. F., RUDIS, M. I. & BOND, C. A. 2006. Critical care pharmacy services in United States hospitals. *Ann Pharmacother,* 40**,** 612-618.

MAKOWSKY, M. J., SCHINDEL, T. J., ROSENTHAL, M., CAMPBELL, K., TSUYUKI, R. T. & MADILL, H. M. 2009. Collaboration between pharmacists, physicians and nurse practitioners: a qualitative investigation of working relationships in the inpatient medical setting. *Journal of interprofessional care,* 23**,** 169-184.

MALONE, D. C., ABARCA, J., SKREPNEK, G. H., MURPHY, J. E., ARMSTRONG, E. P., GRIZZLE, A. J., REHFELD, R. A. & WOOSLEY, R. L. 2007. Pharmacist Workload and Pharmacy Characteristics Associated With the Dispensing of Potentially Clinically Important Drug-Drug Interactions. *Medical Care,* 45**,** 456-462 10.1097/01.mlr.0000257839.83765.07.

MARCONI, G. P. & CLAUDIUS, I. 2012. Impact of an Emergency Department Pharmacy on Medication Omission and Delay. *Pediatr Emer Care,* 28**,** 30-33.

MARSHALL, B. C., CUNNY, K. A. & LAWSON, K. A. 1997. HIV-positive males' satisfaction with pharmacy services. *Journal of the American Pharmaceutical Association (Washington,D.C. : 1996),* NS37**,** 66-75.

MARTINEZ-ANTON, A., SANCHEZ, J. I. & CASANUEVA, L. 2012. Impact of an intervention to reduce prescribing errors in a pediatric intensive care unit. *Intensive Care Med.,* 38**,** 1532-1538.

MCDONOUGH, P. R. & DOUCETTE, W. R. 2001. Developing colloborative working relationship between pharmacists and physicians. *Journal of the American Pharmaceutical Association* 41**,** 682-692.

MCKEE, M., FREI, B. L., GARCIA, A., FIKE, D. & SOEFJE, S. A. 2011. Impact of clinical pharmacy services on patients in an outpatient chemotherapy academic clinic. *Journal of Oncology Pharmacy Practice,* 17**,** 387-394.

MCLEOD, M. C., BARBER, N. & FRANKLIN, B. D. 2013. Methodological variations and their effects on reported medication administration error rates. *BMJ Qual Saf.*

MCPHERSON, K. 2001. Working and learning together: good quality care depends on it, but how can we achieve it? . *Qual Health Care,* 10(Suppl 2)**,** 1046-1053.

MIRANDA, T. M. M., PETRICCIONE, S., FERRACINI, F. T. & BORGES FILHO, W. M. B. 2012. Interventions performed by the clinical pharmacist in the emergency department. *einstein,* 10**,** 74-78.

MORATÓ, J. F., RUIZ, A. G., CASTELL, P. A., SABARTÉS, L. V., SANSÓN, F. P. & PÉREZ, S. R. 2012. Analysis of medication errors in a private hospital: pharmacist interventions. *Eur J Hosp Pharm 2012 19: 102-103,* 19**,** 102-103.

MORIMOTO, T., FUKUI, T., LEE, T. H. & MATSUI, K. 2004a. Application of US guidelines in other countries: aspirin for the primary prevention of cardiovascular events in Japan. *The American journal of medicine,* 117**,** 459-468.

MORIMOTO, T., GANDHI, T. K., SEGER, A. C., HSIEH, T. C. & BATES, D. W. 2004b. Adverse drug events and medication errors: detection and classification methods. *Qual Saf Health Care,* 13**,** 306-14.

MUIJRERS, P. E., GROL, R., SIJBRANDIJ, J., JANKNEGT, R. & KNOTTNERUS, J. A. 2005. Differences in prescribing between GPs: impact of the cooperation with pharmacists and impact of visits from pharmaceutical industry representatives.

MUIJRERS, P. E., KNOTTNERUS, J. A., SIJBRANDIJ, J., JANKNEGT, R. & GROL, R. P. 2003. Changing relationships: attitudes and opinions of general practitioners and pharmacists regarding the role of the community pharmacist. . *Pharm World Sci* 23**,** 235-241.

MURRAY, M. D., RITCHEY, M. E., WU, J. & TU, W. 2009. Effect of a pharmacist on adverse drug events and medication errors in outpatients with cardiovascular disease. *Arch Intern Med,* 169**,** 757-63.

NAZER, L. H., ELJABER, R., RIMAWI, D. & HAWARI, F. I. 2012. Adverse drug events resulting in admission to the intensive care unit in oncology patients: Incidence, characteristics and associated cost. *J Oncol Pharm Pract*.

NCC-MERP. 1998. *Taxonomy of medication errors* [Online]. National Coordinating Council for Medication Error Reporting and Prevention. Available: http://www.nccmerp.org [Accessed December 2013].

NEBEKER, J. R., BARACH, P. & SAMORE, M. H. 2004. Clarifying adverse drug events: a clinician's guide to terminology, documentation, and reporting. *Ann Intern Med,* 140**,** 795-801.

NGUYEN, E. E., CONNOLLY, P. M. & WONG, V. 2010. Medication safety initiative in reducing medication errors. *J Nurs Care Qual,* 25**,** 224-30.

NHSSCOTLAND. 2013. *Scottish Patient Safety Programme* [Online]. Scotland. Available: http://www.scottishpatientsafetyprogramme.scot.nhs.uk/ [Accessed December 2013].

NIEVA, V. F. & SORRA, J. 2003. Safety culture assessment: a tool for improving patient safety in healthcare organizations. *Quality and Safety in Health Care,* 12**,** ii17-ii23.

NUNES, C. F. P., ANDREOLI, P. B. A., FERRACINI, F. T. & BARROS, C. G. 2013. A Survey of Medication Error Prevalence in a Brazilian Health Center. *J Nurs Care Qual,* 28**,** 92-97.

OPARAH, A. & EFERAKEYA, A. 2005. Attitudes of Nigerian Pharmacists towards Pharmaceutical Care. *Pharmacy World and Science,* 27**,** 208-214.

OPARAH, A. C., ENATO, E. F. O. & AKORIA, O. A. 2004. Assessment of patient satisfaction with pharmaceutical services in a Nigerian teaching hospital. *International Journal of Pharmacy Practice,* 12**,** 7-12.

ORGANIZATION, W. H. 2006. *Action on Patient Safety-High 5s.* [Online]. WHO. Available: http://www.who.int/patientsafety/implementation/solutions/high5s/en/index.html [Accessed February 2014].

OSWALD, S. & CALDWELL, R. 2007a. Dispensing error rate after implementation of an automated pharmacy carousel system. *Am J Health Syst Pharm,* 64**,** 1427-1431.

OSWALD, S. & CALDWELL, R. 2007b. Dispensing error rate after implementation of an automated pharmacy carousel system

. *Am J Health-Syst Pharm. ,* 64**,** 1427-1431.

OZKAN, S., KOCAMAN, G., OZTURK, C. & SEREN, S. 2011. Frequency of pediatric medication administration errors and contributing factors. *J Nurs Care Qual,* 26**,** 136-43.

PAGNAMENTA, A., RABITO, G., AROSIO, A., PERREN, A., MALACRIDA, R., BARAZZONI, F. & DOMENIGHETTI, G. 2012. Adverse event reporting in adult intensive care units and the impact of a multifaceted intervention on drug-related adverse events. *Ann Intensive Care,* 2**,** 47.

PATANWALA, A. E., SANDERS, A. B., THOMAS, M. C., ACQUISTO, N. M., WEANT, K. A., BAKER, S. N., MERRITT, E. M. & ERSTAD, B. L. 2012. A prospective, multicenter study of pharmacist activities resulting in medication error interception in the emergency department. *Ann Emerg Med,* 59**,** 369-73.

PATANWALA, A. E., WARHOLAK, T. L., SANDERS, A. B. & ERSTAD, B. L. 2010. A prospective observational study of medication errors in a tertiary care emergency department. *Ann Emerg Med,* 55**,** 522-6.

PATTERSON, E. S., COOK, R. I. & RENDER, M. L. 2002. Improving patient safety by identifying side effects from introducing bar coding in medication administration. *J Am Med Inform Assoc,* 9**,** 540-53.

PETH, H. A. J. 2003. Medication errors in the emergency department: a systems approach to minimizing risk. *Emerg Med Clin North Am.,* 21**,** 141-158.

PHARMACY, A. C. O. C., HAMMOND, R. W., SCHWARTZ, A. H., CAMPBELL, M. J., REMINGTON, T. L., CHUCK, S., BLAIR, M. M., VASSEY, A. M., ROSPOND, R. M., HERNER, S. J. & WEBB, C. E. 2003. Collaborative Drug Therapy Management by Pharmacists—2003. *Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy,* 23**,** 1210-1225.

PIRMOHAMED, M., JAMES, S., MEAKIN, S., GREEN, C., SCOTT, A. K., WALLEY, T. J., FARRAR, K., PARK, B. K. & BRECKENRIDGE, A. M. 2004. Adverse drug reactions as cause of admission to hospital: prospective analysis of 18 820 patients. *Bmj,* 329**,** 15-19.

PITTET, D. & DONALDSON, S. L. 2005. Clean care is safer care: the first global challenge of the WHO World Alliance for Patient Safety. *Infection control and hospital epidemiology,* 26**,** 891-894.

POON, E. G., CINA, J. L., CHURCHILL, W. W., MITTON, P., MCCREA, M. L., FEATHERSTONE, E., KEOHANE, C. A., ROTHSCHILD, J. M., BATES, D. W. & GANDHI, T. K. 2005. Effect of bar-code technology on the incidence of medication dispensing errors and potential adverse drug events in a hospital pharmacy. *AMIA Annu Symp Proc***,** 1085.

POON, E. G., KEOHANE, C. A., YOON, C. S., DITMORE, M., BANE, A., LEVTZION-KORACH, O., MONIZ, T., ROTHSCHILD, J. M., KACHALIA, A. B., HAYES, J., CHURCHILL, W. W., LIPSITZ, S., WHITTEMORE, A. D., BATES, D. W. & GANDHI, T. K. 2010. Effect of bar-code technology on the safety of medication administration. *N Engl J Med,* 362**,** 1698-707.

POTE, S., TIWARI, P. & D'CRUZ, S. 2007. Medication prescribing errors in a public teaching hospital in India: A prospective study. *Pharmacy Practice (Internet),* 5**,** 17-20.

RAJU, T. K., THORNTON, J., KECSKES, S., PERRY, M. & FELDMAN, S. 1989. Medication errors in neonatal and paediatric intensive-care units. *The Lancet,* 334**,** 374-376.

REASON, J. 1990a. The contribution of latent human failures to the breakdown of complex systems. *Philos Trans R Soc Lond B Biol Sci,* 327**,** 475-84.

REASON, J. 1995a. A Systems-Approach toOrganizational Error. *Ergonomics,* 38**,** 1708-1721.

REASON, J. 1995b. Understanding adverse events: human factors. *Qual Health Care,* 4**,** 80-9.

REASON, J. 2000a. Human error: models and management. *West J Med,* 172**,** 393-6.

REASON, J. 2000b. Human error: models and management. *BMJ,* 320**,** 768-70.

REASON, J. 2004. Beyond the organisational accident: the need for "error wisdom" on the frontline. *Qual Saf Health Care,* 13 Suppl 2**,** ii28-33.

REASON, J. T. 1990b. *Human error,* Cambridge, Cambridge university press.

REASON, J. T. 1990c. *Human error. ,* Cambridge, Cambridge university press.

RECKMANN, M. H., WESTBROOK, J. I., KOH, Y., LO, C. & DAY, R. O. 2009. Does computerized provider order entry reduce prescribing errors for hospital inpatients? A systematic review. . *J Am Med Inform Assoc,* 16**,** 613-623.

REDWOOD, S., RAJAKUMAR, A., HODSON, J. & COLEMAN, J. 2011. Does the implementation of an electronic prescribing system create unintended medication errors? A study of the sociotechnical context through the analysis of reported medication incidents. *BMC medical informatics and decision making,* 11**,** 29.

REILLY, T., BARILE, D. & REUBEN, S. 2012. Role of the pharmacist on a general medicine acute care for the elderly unit. *Am J Geriatr Pharmacother,* 10**,** 95-100.

REX, J. H., TURNBULL, J. E., ALLEN, S. J., VANDE VOORDE, K. & LUTHER, K. 2000. Systematic root cause analysis of adverse drug events in a tertiary referral hospital. *Jt Comm J Qual Improv,* 26**,** 563-75.

RITCHEY, F. J. & RANEY, M. R. 1981. Effect of exposure on physicians' attitudes toward clinical pharmacists. *Am J Hosp Pharm* 38**,** 1459–1463.

ROBERTS, D. E., SPENCER, M. G., BURFIELD, R. & BOWDEN, S. 2002. An analysis of dispensing errors in NHS hospitals. *International Journal of Pharmacy Practice,* 10**,** R6-R6.

RODRIGUEZ-GONZALEZ, C. G., HERRANZ-ALONSO, A., MARTIN-BARBERO, M. L., DURAN-GARCIA, E., DURANGO-LIMARQUEZ, M. I., HERNANDEZ-SAMPELAYO, P. & SANJURJO-SAEZ, M. 2012. Prevalence of medication administration errors in two medical units with automated prescription and dispensing. *J Am Med Inform Assoc,* 19**,** 72-8.

ROLLAND, P. 2004. Occurrence of dispensing errors and efforts to reduce medication errors at the Central Arkansas Veteran's Healthcare System. *Drug safety,* 27**,** 271-282.

ROSS, S., RYAN, C., DUNCAN, E. M., FRANCIS, J. J., JOHNSTON, M., KER, J. S., LEE, A. J., MACLEOD, M. J., MAXWELL, S., MCKAY, G., MCLAY, J., WEBB, D. J. & BOND, C. 2012. Perceived causes of prescribing errors by junior doctors in hospital inpatients: a study from the PROTECT programme. *BMJ Qual Saf* 0**,** 1-6.

ROTHSCHILD, J. M., LANDRIGAN, C. P., CRONIN, J. W., KAUSHAL, R., LOCKLEY, S. W., BURDICK, E., STONE, P. H., LILLY, C. M., KATZ, J. T., CZEISLER, C. A. & BATES, D. W. 2005. The Critical Care Safety Study: The incidence and nature of adverse events and serious medical errors in intensive care. *Crit Care Med,* 33**,** 1694-700.

ROUGH, S. S., MCDANIEL, M. & RINEHART, J. R. 2010. Effective use of workload and productivity monitoring tools in health-system pharmacy,part 1. . *Am J Health-Syst Pharm.,* 67**,** 300-311.

RUNCIMAN, W., HIBBERT, P., THOMSON, R., VAN DER SCHAAF, T., SHERMAN, H. & LEWALLE, P. 2009. Towards an International Classification for Patient Safety: key concepts and terms. *International Journal for Quality in Health Care,* 21**,** 18-26.

RUNCIMAN, W. B. 2002. Lessons from the Australian Patient Safety Foundation: setting up a national patient safety surveillance system—is this the right model? *Quality and Safety in Health Care,* 11**,** 246-251.

RUPP, M. T., DEYOUNG, M. & SCHONDELMEYER, S. W. 1992. Prescribing problems and pharmacist interventions in community practice. *Medical Care,* 30**,** 926-940.

SANGHERA, I. S. & FRANKLIN, B. D. 2007. The attitudes and beliefs of healthcare professionals on the causes and reporting of medication errors in a UK Intensive care unit. *Anaesthesia* 62**,** 53-61.

SARKAR, U., LOPEZ, A., MASELLI, J. H. & GONZALES, R. 2011. Adverse drug events in U.S. adult ambulatory medical care. *Health Serv Res,* 46**,** 1517-33.

SCHILLIG, J., KAATZ, S., HUDSON, M., KROL, G. D., SZANDZIK, E. G. & KALUS, J. S. 2011. Clinical and safety impact of an inpatient Pharmacist-Directed anticoagulation service. *Journal of Hospital Medicine,* 6**,** 322-328.

SCHNEIDER, M. P., COTTING, J. & PANNATIER, A. 1998. Evaluation of nurses' errors associated in the preparation and administration of medication in a pediatric intensive care unit. *Pharm World Sci,* 20**,** 178-82.

SCHNIPPER, J. L., KIRWIN, J. L., COTUGNO, M. C., WAHLSTROM, S. A., BROWN, B. A., TARVIN, E., KACHALIA, A., HORNG, M., ROY, C. L., MCKEAN, S. C. & BATES, D. W. 2006. Role of pharmacist counseling in preventing adverse drug events after hospitalization. *Arch Intern Med,* 166**,** 565-71.

SCOTT, H. D., THACHER-RENSHAW, A., ROSENBAUM, S. E., WATERS, W. J., GREEN, M., ANDREWS, L. G. & FAICH, G. A. 1990. Physician reporting of adverse drug reactions: results of the Rhode Island adverse drug reaction reporting project. *Jama,* 263**,** 1785-1788.

SENDERS, J. W. & MORAY, N. 1991. *Human error: Course, Prediction and Reduction.,* Hillsdale, NJ, Lawrence Earlbaum Associates.

SHAWAHNA, R., RAHMAN, N.-U., AHMAD, M., DEBRAY, M., YLIPERTTULA, M. & DECLE`VES, X. 2011a. Electronic prescribing reduces prescribing error in public hospitals. *Journal of Clinical Nursing,* 20**,** 3233-3245.

SHAWAHNA, R., RAHMAN, N. U., AHMAD, M., DEBRAY, M., YLIPERTTULA, M. & DECLEVES, X. 2011b. Electronic prescribing reduces prescribing error in public hospitals. *J Clin Nurs,* 20**,** 3233-45.

SHULMAN, R., SINGER, M., GOLDSTONE, J. & BELLINGAN, G. 2005. Medication errors: a prospective cohort study of hand-written and computerised physician order entry in the intensive care unit. *Crit Care,* 9**,** R516-21.

SIKDAR, K. C., ALAGHEHBANDAN, R., MACDONALD, D., BARRETT, B., COLLINS, K. D., DONNAN, J. & GADAG, V. 2010. Adverse drug events in adult patients leading to emergency department visits. *Ann Pharmacother,* 44**,** 641-9.

SILEN-LIPPONEN, M., TOSSAVAINEN, K., TURUNEN, H. & SMITH, A. 2005. Potential Errors and Their Prevention in Operating Room Teamwork as Experienced by

Finnish, British and American Nurses. *International Journal of Nursing Practice* 11**,** 21-32.

SILVA, A. E., REIS, A. M., MIASSO, A. I., SANTOS, J. O. & CASSIANI, S. H. 2011. Adverse drug events in a sentinel hospital in the State of Goias, Brazil. *Rev Lat Am Enfermagem,* 19**,** 378-86.

SILVA, D. C., ARAUJO, O. R., ARDUINI, R. G., ALONSO, C. F., SHIBATA, A. R. & TROSTER, E. J. 2013. Adverse drug events in a paediatric intensive care unit: a prospective cohort. *BMJ Open,* 3.

SMITH, F. 2009. Private local pharmacies in low-and middle-income countries: a review of interventions to enhance their role in public health. *Tropical Medicine & International Health,* 14**,** 362-372.

SMITH, J. 2004. *Building a safer NHS for patients: improving medication safety*, NHS Health Development Agency.

SMITS, M., WAGNER, C., SPREEUWENBERG, P., TIMMERMANS, D. R. M., VAN DER WAL, G. & GROENEWEGEN, P. P. 2012. The role of patient safety culture in the causation of unintended events in hospitals. *Journal of clinical nursing,* 21**,** 3392-3401.

SPENCER, J. A. & EDWARDS, C. 1992. Pharmacy beyond the dispensary: general practitioners' views. *BMJ: British Medical Journal,* 304**,** 1670.

STELFOX, H. T., PALMISANI, S., SCURLOCK, C., ORAV, E. J. & BATES, D. W. 2006. The ‘‘To Err is Human’’ report and the patient safety Literature. *Qual Saf Health Care,* 15**,** 174-178.

STEWART, D. C., GEORGE, J., BOND, C. M., CUNNINGHAM, I. T. S., DIACK, H. L. & MCCAIG, D. J. 2008. Exploring patients’ perspectives of pharmacist supplementary prescribing in Scotland. *Pharmacy world & science,* 30**,** 892-897.

STUBBS, J., HAW, C. & MOUNTJOY, C. 2003. Medication errors in psychiatry. *Psychiatr Serv,* 54**,** 1164; author reply 1165.

SVARSTAD, B. L., BULTMAN, D. C. & MOUNT, J. K. 2003. Patient counseling provided in community pharmacies: effects of state regulation, pharmacist age, and busyness. *Journal of the American Pharmacists Association: JAPhA,* 44**,** 22-29.

TAHAINEH, L. M., WAZAIFY, M., ALBSOUL-YOUNES, A., KHADER, Y. & ZAIDAN, M. 2009. Perceptions, experiences, and expectations of physicians in hospital settings in Jordan regarding the role of the pharmacist. *Research in Social and Administrative Pharmacy* 5**,** 63-70.

TAM, V. C., KNOWLES, S. R., CORNISH, P. L., FINE, N., MARCHESANO, R. & ETCHELLS, E. E. 2005. Frequency, type and clinical importance of medication history errors at admission to hospital: a systematic review. . *CMAJ,* 173**,** 510-515.

TANG, F. I., SHEU, S. J., YU, S., WEI, I. L. & CHEN, C. H. 2007. Nurses relate the contributing factors involved in medication errors. *Journal of clinical nursing,* 16**,** 447-457.

TARIQ, A., GEORGIOU, A. & WESTBROOK, J. 2012. Medication incident reporting in residential aged care facilities: limitations and risks to residents' safety. *BMC Geriatr,* 12**,** 67.

TAXIS, K. & BARBER, N. 2003a. Ethnographic study of incidence and severity of intravenous drug errors. *Bmj,* 326**,** 684.

TAXIS, K. & BARBER, N. 2004. Incidence and severity of intravenous drug errors in a German hospital. *Eur J Clin Pharmacol,* 59**,** 15-17.

TAXIS, K. & BARBER, N. 2003b. Causes of intravenous medication errors: an ethnographic study. *Qual Saf Health Care,* 12**,** 343-348.

THOMAS, A. N. & PANCHAGNULA, U. 2008. Medication-related patient safety incidents in critical care: a review of reports to the UK National Patient Safety Agency. *Anaesthesia,* 63**,** 726-33.

THOMAS, E. J. & PETERSEN, L. A. 2003. Measuring errors and adverse events in health care. *Journal of General Internal Medicine,* 18**,** 61-67.

THOMAS, E. J., SEXTON, J. B. & HELMREICH, R. L. 2003. Discrepant attitudes about teamwork among critical care nurses and physicians*. *Critical Care Medicine,* 31**,** 956-959 10.1097/01.CCM.0000056183.89175.76.

THOMPSON, J. D. 1976. *Organisations in Action,* New York, NY, McGraw-Hill.

TISSOT, E., CORNETTE, C., LIMAT, S., MOURAND, J. L., BECKER, M., ETIEVENT, J. P., DUPOND, J. L., JACQUET, M. & WORONOFF-LEMSI, M. C. 2003. Observational study of potential risk factors of medication administration errors. *Pharm World Sci,* 25**,** 264-8.

TONNA, A. P., STEWART, D., WEST, B. & MCCAIG, D. 2007. Pharmacist prescribing in the UK–a literature review of current practice and research. *Journal of clinical pharmacy and therapeutics,* 32**,** 545-556.

TUFFAHA, H. W. & KOOPMANS, S. M. 2012. Development and implementation of a method for characterizing clinical pharmacy interventions and medication use in a cancer center. *Journal of Oncology Pharmacy Practice,* 18**,** 180-185.

ULANIMO, V. M., O'LEARY-KELLEY, C. & CONNOLLY, P. M. 2007. Nurses' perceptions of causes of medication errors and barriers to reporting. *J Nurs Care Qual,* 22**,** 28-33.

VALENSTEIN, M., KAVANAGH, J., LEE, T., REILLY, P., DALACK, G. W., GRABOWSKI, J., SMELSON, D., RONIS, D. L., GANOCZY, D. & WOLTMANN, E. 2011. Using a pharmacy-based intervention to improve antipsychotic adherence among patients with serious mental illness. *Schizophrenia Bulletin,* 37**,** 727-736.

VAN DEN BEMT, P. & EGBERTS, A. C. G. 2007. Drug related problems: definitions and classification. *European Journal of Hospital Pharmacy Practice,* 2007**,** 62-64.

VAN DEN BEMT, P. M., IDZINGA, J. C., ROBERTZ, H., KORMELINK, D. G. & PELS, N. 2009. Medication administration errors in nursing homes using an automated medication dispensing system. *J Am Med Inform Assoc,* 16**,** 486-92.

VAN DEN BEMT, P. M. L. A., ROEL FIJN, R., VAN DER VOORT, P. H. J., GOSSEN, A. A., EGBERTS, T. C. G. & BROUWERS, J. R. B. J. 2002. Frequency and determinants of drug administration errors in the intensive care unit. *Crit Care Med,* 30**,** 846-850.

VAN DOORMAAL, J. E., ROMMERS, M., KOSTERINK, J., TEEPE-TWISS, I., HAAIJER-RUSKAMP, F. & MOL, P. 2010. Comparison of methods for identifying patients at risk of medication-related harm. . *Qual Saf Health Care* 19**,** 26.

VAN DOORMAAL, J. E., VAN DEN BEMT, P. M., ZAAL, R. J., EGBERTS, A. C., LENDERINK, B. W., KOSTERINK, J. G., HAAIJER-RUSKAMP, F. M. & MOL, P. G. 2009. The influence that electronic prescribing has on medication errors and preventable adverse drug events: an interrupted time-series study. *J Am Med Inform Assoc,* 16**,** 816-25.

VARDI, A., EFRATI, O., LEVIN, I., MATOKB, I., RUBINSTEINA, M., PARETA, G. & BARZILAYA, Z. 2007. Prevention of potential errors in resuscitation medications orders by means of a computerised physician order entry in paediatric critical care. *Resuscitation,* 73**,** 400-406.

VAZIRANI, S., HAYS, R. D., SHAPIRO, M. F. & COWAN, M. 2005. Effect of a multidisciplinary intervention on communication and collaboration among physicians and nurses. *American Journal of Critical Care,* 14**,** 71-77.

VEGGELAND, T. & DYB, S. 2008. The contribution of a clinical pharmacist to the improvement of medication at a geriatric hospital unit in Norway. *Pharmacy Practice,* 6**,** 20-24.

VELO, G. P. & MINUZ, P. 2009. Medication errors: prescribing faults and prescription errors. *British journal of clinical pharmacology,* 67**,** 624-628.

VESSAL, G. 2010. Detection of prescription errors by a unit-based clinical pharmacist in a nephrology ward. *Pharmacy world & science,* 32**,** 59-65.

VIKTIL, K. K. & BLIX, H. S. 2008. The impact of clinical pharmacists on drug-related problems and clinical outcomes. . *Basic Clin Pharmacol Toxicol,* 102**,** 275-280.

VINCENT, C. 2006. *Patient Safety,* Edinburgh, Elsevier Churchill Livingstone.

VINCENT, C. 2010. *Patient Safety,* Wiley-blackwell Publishers.

VINCENT, C., BARBER, N., FRANKLIN, B. & AL, E. 2009. The contribution of pharmacy to making Britain a safer place to take medicines. London: Royal Pharmaceutical Society of Great Britain.

WACHTER, R. M. 2004. The end of the beginning: patient safety five years after "To Err Is Human.". *Health Affairs,* 23**,** 534-545.

WEINGART, S. N., TOTH, M., ENEMAN, J., ARONSON, M. D., SANDS, D. Z., SHIP, A. N., DAVIS, R. B. & PHILLIPS, R. S. 2004. Lessons from a patient partnership intervention to prevent adverse drug events. *Int J Qual Health Care,* 16**,** 499-507.

WESTBROOK, J. I., ROB, M. I., WOODS, A. & PARRY, D. 2011. Errors in the administration of intravenous medications in hospital and the role of correct procedures and nurse experience. *BMJ Qual Saf* 20**,** 1027-1034.

WETTERNECK, T. B., WALKER, J. M., BLOSKY, M. A., CARTMILL, R. S., HOONAKKER, P., JOHNSON, M. A., NORFOLK, E. & CARAYON, P. 2011. Factors contributing to an increase in duplicate medication order errors after CPOE implementation. *J Am Med Inform Assoc,* 18**,** 774-82.

WHA 2002. Quality of care: patient safety - resolution WHA55.18. *In:* WHO (ed.). Geneva: WHO.

WHO 1972. International drug monitoring: the role of national centres. *Tech Rep Ser WHO,* 498.

WHO. 2006. *World Alliance for Patient Safety forward programme* [Online]. Geneva: World Health Organization. Available: http://www.who.int/ patientsafety/ information_centre/ WHO_EIP_HDS_PSP_2006.1.pdf [Accessed December 2013].

WHO. 2010. *Key components of a well functioning health system* [Online]. World Health Organization. [Accessed 20-11-2013.

WHO ARE, A. 2008. What is Clinical Pharmacy. *Pharmacotherapy,* 28**,** 816-817.

WILHELMSSON, S., EK, A. C. & ÅKERLIND, I. 2001. Opinions about district nurses prescribing. *Scandinavian journal of caring sciences,* 15**,** 326-330.

WILKINSON, R. 1996. Nurses' concern about IV therapy and devices. *Nurs Stand,* 10**,** 35-37.

WILMER, A., LOUIE, K., DODEK, P., WONG, H. & AYAS, N. 2010. Incidence of medication errors and adverse drug events in the ICU: a systematic review. *Qual Saf Health Care,* 19**,** e7.

WILSON, R. M., MICHEL, P., OLSEN, S., GIBBERD, R. W., VINCENT, C., EL-ASSADY, R., RASSLAN, O., QSOUS, S., MACHARIA, W. M. & SAHEL, A. 2012. Patient safety in developing countries: retrospective estimation of scale and nature of harm to patients in hospital. *Bmj,* 344.

WILSON, R. M., RUNCIMAN, W. B., GIBBERD, R. W., HARRISON, B. T., NEWBY, L. & HAMILTON, J. D. 1995. The quality in Australian health care study. *Medical Journal of Australia,* 163**,** 458-471.

WOLF, Z., SEREMBUS, J., SMETZER, J., COHEN, H. & COHEN, M. 2000. Responses and concerns of healthcare providers to medication errors. . *Journal for Advanced Nursing Practice,* 14**,** 278-287.

WRIGHT, A. A. & KATZ, I. T. 2005. Bar coding for patient safety. *N Engl J Med,* 353**,** 329-331.

WU, A. W., PRONOVOST, P. & MORLOCK, L. 2002. ICU incident reporting systems. *J Crit Care,* 17**,** 86-94.

YAMAMOTO, L. & KANEMORI, J. 2010. Comparing errors in ED computer-assisted vs conventional pediatric drug dosing and administration. *American Journal of Emergency Medicine,* 28**,** 588–592.

YOUSIF, M. A., NIZAR, S., ELMUSTAFA, M. O., MUSTAFA, M. I. & BELLA, M. M. 2011. Investigation of medication prescribing errors in Wad Medani, Gezira, Sudan. *The International Journal of Risk and Safety in Medicine,* 23**,** 11-16.

YU, K. H., NATION, R. L. & DOOLEY, M. J. 2005. Multiplicity of medication safety terms, definitions and functional meanings: when is enough enough? *Qual Saf Health Care,* 14**,** 358-63.

ZAIDAN, M., SINGH, R., WAZAIFY, M. & TAHAINEH, L. 2011. Physicians' perceptions, expectations, and experience with pharmacists at Hamad Medical Corporation in Qatar. *Journal of multidisciplinary healthcare,* 4**,** 85.

ZAKARIA, A. 2014. 2 children lose limbs. *Daily Graphic,* February 11, 2014, p.1.

ZED, P. J. 2005. Drug-related visits to the emergency department. . *J Pharm Pract* 18**,** 329-335.

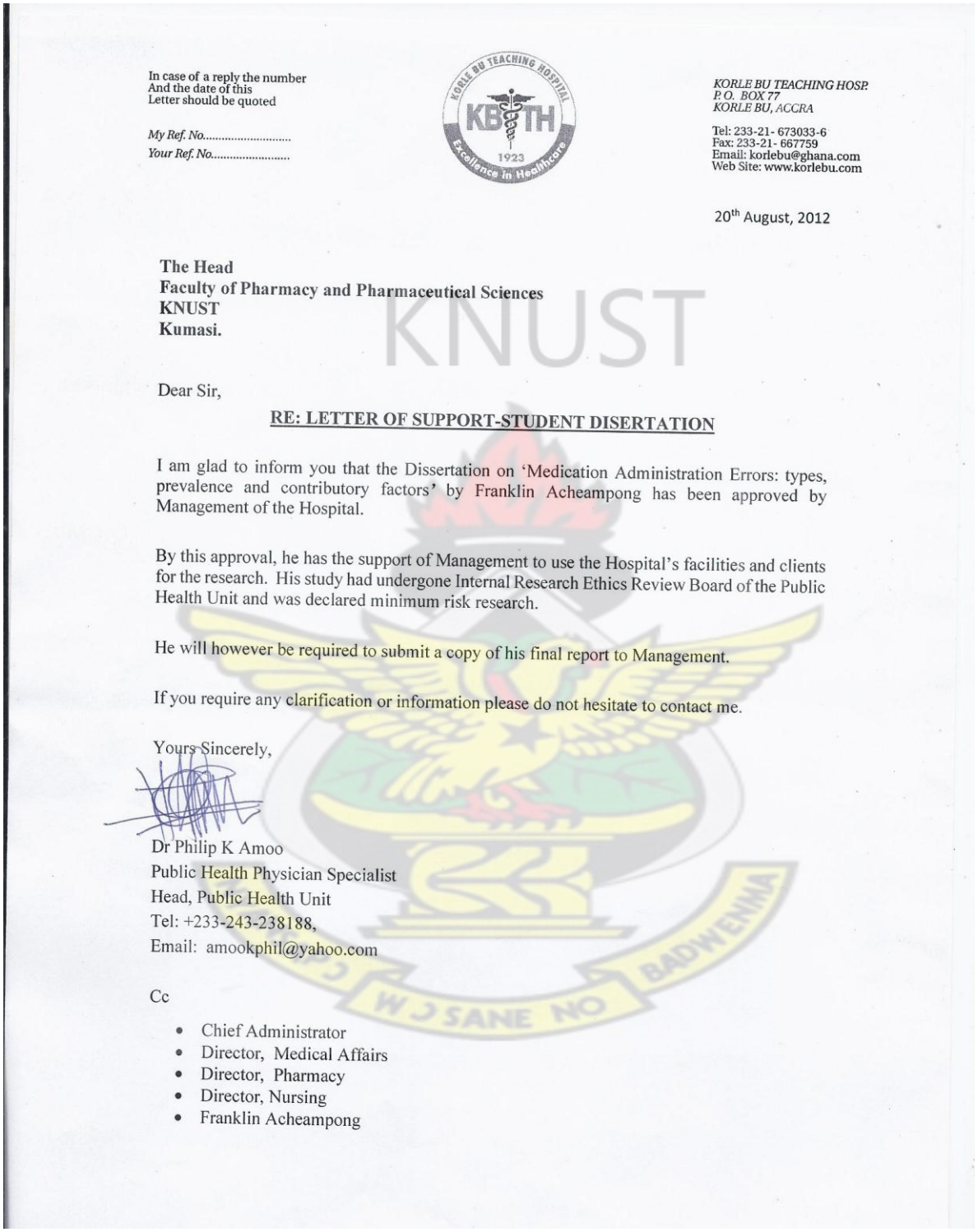
ZHAN, C., SMITH, S. R., KEYES, M. A., HICKS, R. W., COUSINS, D. D. & CLANCY, C. M. 2008. How useful are voluntary medication error reports? The case of warfarin-related medication errors. *Joint Commission Journal on Quality and Patient Safety,* 34**,** 36-45.

ZILLICH, A. J., MCDONOUGH, R. P., CARTER, B. L. & DOUCETTE, W. R. 2004. Influential characteristics of physician/pharmacist collaborative relationships. *Ann Pharmacother,* 38**,** 764-70.

ZWARENSTEIN, M. 2009. Interprofessional collaboration: effects of practice-based interventions on professional practice and healthcare outcomes (Review). The Cochrane Library.

Appendices

APPENDIX 3.1: Internal Research Ethical Approval of Korle Bu Public Health Unit



In case of a reply the number
And the date of this
Letter should be quoted

My Ref. No.....
Your Ref. No.....

KORLE BU TEACHING HOSPITAL
KBTH
1923
Excellence in Healthcare

KORLE BU TEACHING HOSP.
P.O. BOX 77
KORLE BU, ACCRA

Tel: 233-21- 673033-6
Fax: 233-21- 667759
Email: korlebu@ghana.com
Web Site: www.korlebu.com

20th August, 2012

The Head
Faculty of Pharmacy and Pharmaceutical Sciences
KNUST
Kumasi.

Dear Sir,

RE: LETTER OF SUPPORT-STUDENT DISERTATION

I am glad to inform you that the Dissertation on 'Medication Administration Errors: types, prevalence and contributory factors' by Franklin Acheampong has been approved by Management of the Hospital.

By this approval, he has the support of Management to use the Hospital's facilities and clients for the research. His study had undergone Internal Research Ethics Review Board of the Public Health Unit and was declared minimum risk research.

He will however be required to submit a copy of his final report to Management.

If you require any clarification or information please do not hesitate to contact me.

Yours Sincerely,

Dr Philip K Amoo
Public Health Physician Specialist
Head, Public Health Unit
Tel: +233-243-238188,
Email: amookphil@yahoo.com

Cc

- Chief Administrator
- Director, Medical Affairs
- Director, Pharmacy
- Director, Nursing
- Franklin Acheampong

Appendix 3.2: Ethical Approval

UNIVERSITY OF GHANA MEDICAL SCHOOL
COLLEGE OF HEALTH SCIENCES
ACADEMIC AFFAIRS OFFICE

Phone: +233-0302-666987-8
Fax: +233-0302-663062
E-mail: academic.ugms@chs.edu.gh
My Ref. No: MS-AA/C.2/Vol.18[A]
Your Ref. No.

P O Box 4236
Accra
Ghana

23rd January, 2014

Mr. Franklin Acheampong
Dept. of Pharmacy
Korle-Bu Teaching Hospital
Korle-Bu

ETHICAL CLEARANCE

Protocol Identification Number: MS-Et/M.3 – P 3.1 /2013-2014

The Ethical and Protocol Review Committee of the University of Ghana Medical School on 22nd January, 2014 unanimously approved your research proposal.

TITLE OF PROTOCOL:"**Medication Administration Errors In A Tertiary Care Emergency Department And Strategies For Medication Safety**"

PRINCIPAL INVESTIGATOR: Mr. Franklin Acheampong

This approval requires that you submit six-monthly review reports of the protocol to the Committee and a final full review to the Ethical and Protocol Review Committee at the completion of the study. The Committee may observe, or cause to be observed, procedures and records of the study during and after implementation.

Please note that any significant modification of this project must be submitted to the Committee for review and approval before its implementation.

You are required to report all serious adverse events related to this study to the Ethical and Protocol Review Committee within seven (7) days verbally and fourteen (14) days in writing.

As part of the review process, it is the Committee's duty to review the ethical aspects of any manuscript that may be produced from this study. You will therefore be required to furnish the Committee with any manuscript for publication.

This ethical clearance is valid till October, 2014.

Please always quote the protocol identification number in all future correspondence in relation to this protocol.

Signed:.....
PROFESSOR JENNIFER WELBECK
(CHAIRPERSON, ETHICAL AND PROTOCOL REVIEW COMMITTEE)

cc: Ag. Dean
Head of Department
Research Office

APPENDIX 3.3: Letter of consent

Pharmacy Department

Korle Bu Teaching Hospital.

Accra

……

Dear Sir/Madam,

INVITATION TO PARTICIPATE IN A STUDY

I, Franklin Acheampong, a PhD student is undertaking a research at the Surgical Medical Emergency Unit. I wish to formally invite you to participate in a study on Medication Administration Errors that will take place in your Unit. The practical benefits of the study will involve ways of improving our services to our patients.

The study will involve an observation of you preparing and administering medication and you may be selected to participate in a 10-20 minutes interview with the investigator at a convenient location of your choice that will ensure your privacy. The transcripts of the interview will be treated with strict confidentiality and will **NOT** be made available to anyone but will only be used for this research purposes. Under **NO** circumstances will your identity be disclosed to anyone apart from the investigator. You are free to withdraw from the study at any time without any consequences.

You will not be paid for participating.

You may contact me for further details on 0242929622.

Yours faithfully,

……

FRANKLIN ACHEAMPONG

Appendix 3.4 Information for consent

Study Title: Medication Administration Errors; types, prevalence and contributory factors

Principal Investigator: Franklin Acheampong (PhD student, Department of Clinical and Social Pharmacy, College of Health Sciences, Kwame Nkrumah University of Science and Technology)

Supervisor: Dr Berko P. Anto (Department of Clinical and Social Pharmacy, College of Health Sciences, KNUST)

• This is information accompanying a consent form for research participation. It contains important information about this study and what to expect if you decide to participate. Please consider the information carefully. Feel free to discuss the study with your friends and family and to ask questions before making your decision whether or not to participate.

• Your participation is voluntary. You may refuse to participate in this study. If you decide to take part in the study, you may leave the study at any time. No matter what decision you make, there will be no penalty to you and you will not lose any of your usual benefits. Your decision will not affect your employment status, your future relationship with the investigator nor his university.

• You may or may not benefit as a result of participating in this study. Also, your participation may result in unintended effects for you that may be minor or may be serious and that are due to natural causes.

• You will be provided with any new information that develops during the study that may affect your decision whether or not to continue to participate. If you decide to participate, you will be asked to sign a form and will receive a copy of the form. You are being asked to consider participating in this study for the reasons explained below.

1. Why is this study being done?

This study is being done to determine the occurrence of medication administration errors and explore strategies for medication safety. Medication administration error is referred to have occurred when what was administered differed from what had been prescribed. You are being asked to participate because you are a nurse who works at Emergency Department of Korle Bu Teaching Hospital (ED).

2. How many people will take part in this study?

A total of 61 nurses who work in the ED will be invited to take part in the study.

3. What will happen if I take part in this study?

You will be observed in your normal patient care activities preparing and administering medications to your patients. If you choose to participate in this study, you will not be asked to do anything differently than you would normally do when administering medications to

your patients. You will then be asked to provide your views about the possible causes of identified errors.

4. How long will I be in the study?

You will be enrolled in the study for 8 weeks.

5. Can I stop being in the study?

You may leave the study at any time. If you decide to stop participating in the study, there will be no penalty to you, and you will not lose any benefits to which you are otherwise entitled.

6. What risks, side effects or discomforts can I expect from being in the study?

You may feel self-conscious about being observed administering medications. Because errors that do not lead to patient harm will be recorded for study purposes only, you should not feel any increased risk of administrative, legal, or punitive action that might not otherwise normally occur. Your attention will be drawn to any error that leads to patient harm. You will be assigned an identification number that will be recorded on your respective questionnaires and observation form. Your name will not be recorded on any of these documents in order to protect your privacy. Thus, your data will be anonymous. The data collected from you will be stored in a database to which only the investigators will have access.

7. What benefits can I expect from being in the study?

While you will not benefit directly from participating in the study, this study fills a significant gap because it is the first in-depth examination of nurses' medication administration error occurrence in Ghana. The overall goal of this research is to improve patient safety. Process changes for medication administration can occur with the input of data such as these.

8. What other choices do I have if I do not take part in the study?

You may choose not to participate without penalty or loss of benefits to which you are otherwise entitled.

9. Will my study-related information be kept confidential?

Efforts will be made to keep your study-related information confidential. However, there may be circumstances where this information must be released. For example, personal information regarding your participation in this study may be disclosed if required by law. Also, your records may be reviewed by the following group:

- Ethical and Protocol Review Committee of the Public Health Unit of Korle Bu Teaching Hospital
- Department of Clinical and Social Pharmacy, Faculty of Pharmacy and Pharmaceutical Sciences, Kwame Nkrumah University of Science and Technology

10. What are the costs of taking part in this study?

There will be no costs to you for participating in this study. You will be observed administering medications on a regularly scheduled day of work.

11. Will I be paid for taking part in this study?

You will not be paid to participate in the study.

12. What happens if I am injured because I took part in this study?

If you suffer an injury from participating in this study, you should notify the researcher immediately, who will determine if you should obtain medical treatment. The cost for this treatment will be billed to you or your insurance.

13. What are my rights if I take part in this study?

- If you choose to participate in the study, you may discontinue participation at any time without penalty or loss of benefits. By signing this form, you do not give up any personal legal rights you may have as a participant in this study. You will be provided with any new information that develops during the course of the research that may affect your decision whether or not to continue participation in the study. You may refuse to participate in this study without penalty or loss of benefits to which you are otherwise entitled.
- For questions, concerns, or complaints about the study you may contact Franklin Acheampong, (0242929622 OR Email: franklinach@hotmail.co.uk), or Dr B. P Anto, Department of Clinical and Social Pharmacy, Faculty of Pharmacy and Pharmaceutical Sciences, Kwame Nkrumah University of Science and Technology, Kumasi.

Appendix 3.5: Consent form

Signing the consent form

I have read this form and I am aware that I am being asked to participate in a research study. I have had the opportunity to ask questions and have had them answered to my satisfaction. I voluntarily agree to participate in this study. I am not giving up any legal rights by signing this form. I will be given a copy of this form.

…… ……

Printed Name Signature

Date……..

Investigator

I have explained the research to the participant before requesting the signature above. There are no blanks in this document. A copy of this form has been given to the participant.

…….

Investigator Name Signature

Date……

Appendix 3.6: Medication administration error data collection tool

Date:	Ward:	TOEs:	No. patients:	No. assists:	Observer:
Time started:	Time stopped:		No. nurses/shift:	Shift:	Data entered:

Pt initials	Sex	Age	No. of drugs ordered	Days stayed	Bed	Drug details	Administrator's Details				Possible causes	Dose observed by researcher?	Drug on chart	Error code	Signature code	Intervened?	No. interruptions	Error classification
							Initials & CODE	Age range	sex	Experience	Years in							
EG	M	45	4	5	9	TAB AUGMENTIN 1g BD	TA, N	2	F	6	3	Forgot to check chart	□	□	□	NN	□	III	B

Additional information for medication administration error data collection

Table 1. ERROR CODES		
CODE	**Type of MAE**	**Description**
*****	No error	
OM	Omission	Failure to administer an ordered drug to a patient
UD	Unauthorised drug	The administration of a drug that was not prescribed for the patient concerned (classified as a wrong drug error if drug X prescribed but drug Y given instead).
WT	*Wrong time*	A dose administered more than one hour before or after the specified time
WP	*Wrong drug preparation*	Errors in drug preparations including incorrect dilution or reconstitution, mixing drugs that are physically incompatible and inadequate product packaging
WD	*Wrong dose*	The administration of the correct drug by the correct route but in a quantity that was not that prescribed (includes administration of incorrect number of dose units, selection of the wrong strength, and the measurement of an incorrect volume of an oral liquid). Where liquid preparations are not measured but instead poured into ungraduated medicines cups, a wrong dose error should be assumed to have occurred only when the observer is certain that the wrong volume has been administered. If failure to shake a bottle of suspension resulted in a visible concentration gradient this is also considered a wrong dose error.
WF	*Wrong dosage form*	The administration of the correct dose of the drug by the correct route but in a formulation that was not prescribed (includes administration of a modified release when non-modified prescribed, and vice versa).
DD	*Drug deteriorated*	Administration of a drug that has exceeded its expiry date or a drug with its physical or chemical integrity compromised.
WA	*Wrong administration technique*	These are doses adminis tered via the wrong route (different from the route prescribed), via the correct route but at the wrong site, and at the wrong rate of administration

TOEs = Total Opportunities for Error which is the sum of all doses ordered plus all the unordered doses given.

Table 2. SIGNATURE CODES	
CODE	**Description**
AS	Dose was administered and signed
AN	Dose administered but not signed
ND	Dose not administered and reason documented
NS	Dose not administered but signed to suggest it was administered
NN	Dose not administered and not signed (blank administration box)

Table 3. MEDICATION ADMINISTRATOR'S CODE	
CODE	**Description**
N	Nurse
NT	Nurse Trainee
NA	Nurse Assistants (Health Extension Workers, Health Assistants Clinical, Enrolled Nurses and Health Care Assistants)
O	Others (patients, relatives & other healthcare professionals)

Table 4. ERROR SIGNIFICANCE CODE	
CODE	**Description**
A	Circumstances or events that have the capacity to cause error
B	An error occurred but the error did not reach the patient
C	An error occurred that reached the patient, but did not cause patient harm
D	An error occurred that reached the patient and required monitoring to confirm that it resulted in no harm to the patient and/or required intervention to preclude harm
E	An error occurred that may have contributed to or resulted in temporary harm to the patient and required intervention
F	An error occurred that may have contributed to or resulted in temporary harm to the patient and required initial or prolonged hospitalization
G	An error occurred that may have contributed to or resulted in permanent patient harm
H	An error occurred that required intervention necessary to sustain life
I	An error occurred that may have contributed to or resulted in the patient's death

Table 5. NURSES' AGE RANGE CODE	
CODE	**Description**
1	<25
2	26-31
3	32-37
4	38-43
5	44-49
6	>50

Table 6. DATA COLLECTION SCHEDULE							
	Mon	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**	**Sun**
6am	□	□	□	□	□	□	√
10am	□	□	□	□	□	□	√
2pm	□	□	□	□	□	□	√
6pm	□	□	□	□	□	√	√
10pm	□	□	□	□	□	√	√

√ = no data collection at all for these drug rounds

Appendix 3.7: Interview schedule guide

Introduction

Name of interviewer…….. Respondent Code…….

I am very grateful for agreeing to participate in this study that tends to explore the potential contributory factors to medication administration errors in the emergency setting. Can you please verbally confirm that you have given written consent to participating in the study.

The discussion will not last beyond 30mins. We would want to discuss how, in your opinion that particular error occurred and what you think might have caused it. You may consider external factors as relating to the patient, your work environment, other co-workers and other factors you consider relevant. You will required to describe briefly the process of the administration of medicine. In addition to that particular incident, you may provide other situations in the past, either with you or others that have resulted in errors.

Finally, you may propose actions to reduce the occurrence of medication administration errors.

Phase 1: Description of how medication administration errors occur

Please, can you describe vividly as possible to events leading to the error.

How was the situation at the patient's bedside?

How many support staff were available? Did you notice anything special happen prior to the incident?

Has such incidents happened before and how does it normally happen?

How would you consider your physical wellbeing at the time of the incident?

Phase 2: Explanation of how external factors contribute to these errors

How do you think the following had influenced the occurrence of the errors - patient, staff, work environment, supervisors,

Now describe the environment in which you work.

What about the attitude of the staff you work with, including your supervisors and manager.

Phase 3: Description of medication administration process

Please tell me about the organization of the emergency unit. How does the ward operate?

Which type of nurses do you have here? In a typical day, briefly describe how your busy day is like?

Looking at the administration process, can you take me through the various stages.

Phase 4: Propose actions to reduce medication administration errors

Finally, in your opinion, how do you think you could have prevented the error from occurring? What other changes would you want to happen at your workplace?

Reporting of errors have been known to help us learn and better our systems and processes. What are your thoughts on reporting of medication administration errors that occur?

Conclusion

Thank you very much for your participation once again. I must admit that it has been very insightful and I have learnt a lot about how medication administration errors occur. I also have recommendations as how to prevent future occurrences. Before you take leave of me, are there other general comments you would like to make concerning the whole study?

Thank you again for your time.

APPENDIX 3.8 Overview of selected studies

Study	Study design and setting	Activities of pharmacists	Clinical outcome
Bond & Raehl (2001)	934-1029 USA hospitals. Database review	• Drug protocol management, • Pharmacist participation on medical rounds	Decreased mortality rate Decreased drug costs Decreased length of stay Decreased 395 deaths/hospital/year
Bond & Raehl (2002)	1081 USA hospitals. 429,827 medication errors database review	• Drug information services • Pharmacist-provided ADR management • Pharmacist-provided drug protocol management • Participation on ward rounds • Admission histories	Decreased medication errors between -9.5 to -0.34 ($p<0.001$)
Bond & Raehl (2006)	584 USA hospitals. 35,193 Medicare patients database review	1. Admission drug histories 2. Drug protocol management 3. ADR management	Reduction of ADR rates 1. OR 1.864(95%CI 1.765-1.968) 2. OR 1.365(95%CI 1.335-1.395) 3. OR 1.360(95%CI 1.328-1.392)

Bond & Raehl (2007a)	860 USA hospitals. 242,704 Medicare patients database review comparing for non and intervention hospital	Pharmacist management of antimicrobial prophylaxis	Death rates 52.06% higher with intervention hospital(105 excess deaths; p<0.0001, OR, 1.54; 95% CI 1.46-1.63)
Hanlon et al (1996)	Randomised controlled trial of 208 elderly patients in USA hospital. Intervention: clinical pharmacist	Evaluation of drug regimes and make recommendations to physicians	Inappropriate prescribing decreased: control 24%, intervention 6% (p=0.0006)
Loewen & Merrett (2010)	Observational study in Canada. Qualitative interviews and quantitative questionnaires	Pharmacist perception of impact of their activities	Time spent positively and significantly correlated with perception of impact(p=0.037)
Kaboli et al (2006b)	Systematic review of 36 included studies (Jan 1, 1985-April 30, 2005). Inpatient pharmacist interventions selected, included control group. Objective patient-specific health outcomes	• Participation on medical rounds • Medication reconciliation • Drug specific pharmacist activities	MEs, ADEs & ADRs reduced in 7 of 12 trials. Medication adherence, knowledge and appropriateness improved 7 of 11 studies. Shortened hospital length of stay in 9 of 11 studies.
Dranitsaris et al (2001)	Randomised control, 323 patients grouped into intervention and non-intervention groups	Pharmacist reviewed use of cefotaxime as compared with hospital guidelines	Improved clinical outcomes in intervention group(94% vs 86%, p=0.018)

Valenstein et al (2011)	Randomised to usual care (n=60) or the pharmacy-based intervention (n=58). Assessment at 6 and 12 months to antipsychotic medication.	• Unit-of-use packaging • Medication and packaging education session • Notification of clinicians when patients don't refill prescriptions	Increase in antipsychotic adherence
Garabedian-Ruffalo et al (1985)	Retrospective chart reviews of patients received warfarin >1year before and after referred to intervention (clinical pharmacist at anticoagulation clinic)	• Provision of patient education • Monitoring of patients for haemorrhagic and thromboembolic complications • Adjust dosage to maintain therapeutic prothrombin time	Patient requiring hospitalisation decreased (39% vs 4%) Prothrombin time outside therapeutic range lower (14.4% vs 35.8%)
Ellis et al(1992)	Before- and after- trial. 52 patients monitored by pharmacy-managed warfarin service	• Chart review • Laboratory interpretation • Recommendations for dosage adjustments • Physician and patient education • Coordination of follow-up in outpatient anticoagulation clinic	• Patients were 12.2 times to be referred to anticoagulation clinic • Patients were 6.7 times compliant • Prothrombin time stability at discharge improved

Boddy (2001)	Compare pharmacist impact on the implementation of warfarin guidelines on anticoagulation control	Pharmacist provided warfarin dosing	• Overall INR maintained within range (58% vs 15%) • Decreased number of INRs requested by 3500
Joosten et al (2013)	1 year Netherland study. Record review before- and after-intervention. Measurement of number of medication errors related to renal impaired patients, n=25,929	Pharmacist recommendation on treatment adjustments	342 medication adjustments made. 88% of identified MEs were potential ADEs and classified significant or serious
Schillig et al (2011)	Cluster randomized trial in large urban teaching hospital and level1 trauma centre	• Pharmacist improve communication regarding anticoagulation • improve safety as patients transition from the inpatient-to-outpatient settings • standardize anticoagulant dosing, • monitoring • patient education.	• Transition of care metric compliance occurred in 73% more patients in the intervention group (P<0.001). • 32% reduction in the composite safety endpoint (P=0.103). • Reduction in rate of INR>5 (P=0.076).

APPENDIX 3.9: Invitation for participation

SURVEY ON PHARMACIST'S ROLE IN MEDICATION SAFETY

Dear Colleague

I am Pharm. Franklin Acheampong, a pharmacist at Korle Bu Teaching Hospital and a student undertaking a survey as part requirement of my PhD programme.

There are different medication safety strategies that have been employed with their attendant challenges. However, pharmacists do play a vital role in the medication use processes. I am interested in learning the role of pharmacists in medication safety and how best to develop such strategies if they exist in our patient care efforts in our hospitals. I sincerely appreciate your input on this topic.It is fully voluntary and please, do not write your name on the questionnaire and fill it to the best of your ability. The information will solely be used for research purposes and treated as confidential as possible. You may stop filling it at any time if you wish not to and there will be no consequences.

Thank you.

For further information, kindly contact me on 0242929622 or franklinach@hotmail.co.uk

APPENDIX 3.10: National Pharmacist Survey questionnaire

KINDLY FILL THE FORM

1	Sex □Male □Female			
2	Name of your hospital		Region	

b	What is the level of care of your hospital? (Please tick as appropriate)	√
	Teaching/Tertiary	
	Regional	
	Municipal	
	District	
	polyclinic	

c	Please, what other qualification(s) do you possess in addition to your undergraduate Pharmacy Degree?

3 a	Please, state the year you completed you undergraduate pharmacy degree	
b	How long have you worked in hospital practice	
c		

	How long have you worked in your current hospital	
d	Which of the following best describes your current role in the hospital? (Please, select ONLY ONE)	
	□Management □Clinical □Research □Dispensing □Compounding	
e	Which of the following areas of specialty do YOU practice in the hospital? (Please, select ONLY ONE)	
	□Paediatric □Surgery □ Emergency □General Medicine □Obs&Gynae Others (Please, state): …	

4a	Which of the following do you perceive to be involved in medication safety in your hospital? (Tick as many as apply)	
	□Physicians □Pharmacists □Nurses □Others…… .	
b	How do you rate YOU and other pharmacists' involvement in medication safety activities in your hospital? (On a scale of 1 to 10, 1=lowest, 10=highest) PLEASE WRITE YOUR SCORE IN THE BOX ⟶	

5	How do you rate the following in terms of your contribution as a pharmacist towards patient care and outcomes (0=no benefit, 7=high benefit)	
	Detection of adverse drug reactions	
	Reporting of adverse drug reactions	
	Reduction of hospital cost	
	Reduction in mortality	
	Reduction in morbidity	

	Reduction in length of patient stay	
	Increase confidence of patient	
	Decrease hospital readmission	

6	Which of the following are you involved in during your routine duties and approximately how much time do you spend on each selected activity? (Select as many as apply)	Tick (√)	Average weekly time spent (hours)
	Interacting with the health care team		
	Counselling out- patients		
	Counselling in- patients		
	Providing patient discharge counselling and follow-up		
	reconciling medications		
	interviewing patients		
	Medication profile and medical record review		
	Presentation of drug regimen recommendations to care team or physician		
	Participating on rounds with inpatient care team		
	Drug monitoring and recommendation follow-up		
	Reconstitution of IV medication		
	Drug therapy dosing or management		
	Documentation of clinical interventions or recommendations		
	Follow-up after discharge		
	Formulation of drug protocols		
	Initiation of therapy		
	Discontinuation of therapy		
	IV to PO conversion		
	Training of students and interns		

	Monitoring of side effects		
	Reporting of medication errors		
	Laboratory reviews		
	Writing of prescriptions		
	Compounding of drugs		
	Responding to drug information questions		

7	Which of the following are your challenges in carrying out the activities as described in box 6 above (Please, tick. More than one may apply)	√
	Lack of supervision	
	No formal schedule by supervisor	
	Lack of interest	
	Inadequate skills and training	
	Spend most time in managerial activities	
	Lack of formal structures of engagement	
	Low confidence to visit bed sides	
	Lack of motivation by superiors	
	Inadequate time available	
	Lack of acceptance by physicians	

8	How would you perceive the attitude of the following towards your involvements in activities selected in box 6 above (Please, tick)	Very positive √	Somewhat positive	Neutral	Somewhat negative	Very negative

	Physicians					
	Nurses					
	Pharmacists					
	Other pharmacy staff					

9a	Do you detect and report medication errors? □YES □NO	
9b	Do you document the interventions made on medication errors? □YES □NO	
If answer to 9b is YES, how do you do the documentation?(Tick as many as apply)		√
Write in patient medical records		
Personal diary or notebook		
Specially designed forms		
Others(state)		

10	Write any other comments on how pharmacists' role in medication safety can be enhanced

Appendix 3.11: Data Extraction Tool

Reporting Pharmacist Details					Details of intervention						
Pharm. ID	Sex	Experience	Highest Education	Dept.	Drug name	Error type	Risk	Reason for error	Clinical intervention	Accepted Y or N	Communication means

Appendix 3.12: Clinical intervention reporting form

CLINICAL INTERVENTION FORM
PHARMACY DEPARTMENT - KORLE BU TEACHING HOSPITAL

PATIENT DETAILS

Surname	Forenames		Weight (kg)	Height (m)
Folder No	Sex	Age	Body Surface Area	
Address			Telephone	

Date of admission	Initial U & Es	Department
Pharmacist	Medical consultant	Ward/Team

PATIENT STAY

Presenting Complaints
Provisional Diagnosis

Date	Past Medical History	Medication History	Risk factors

Date	Description of Medical or Pharmaceutical Problem	Date	Medication used to treat problem or causing problem	Comments

CONTINUATION SHEET

Date	Pharmaceutical Care issues	Intervention/ Action	Outcome

INVESTIGATION							LFTs	Date					
Na (135 - 150mmol/l							Tot. Bil (3.4-22.2umol/l)						
K (3.5 - 5.5mmol/l)							Dir. Bil (0.0-10.2umol/l)						
Urea (2 - 7mmol/l)							Indir. Bil (30-270umol/l)						
Creat (53 - 120µmol/l)							AST (9-44U/l)						
Hb (11-16F G/dl), (14.5-18M G/dl)							ALT (10-40U/l)						
WBC (2.6-8.5*10^9/l)							GGT (0-40U/l)						
Platlets (150-400*10^9)							Alk Phos (30-270U/l)						
OTHERS							Tot. Prot. (60-86g/l)						
							Alb (35-50g/l)						
							Globulins (25-36g/l)						

DISCHARGE COUNSELLING

Discharge Date (Planned)	Discharge Date(Actual)	Discharge To	Newly Diagnosed Condition
			Known Chronic Condition

PHARMACEUTICAL ISSUES CONSIDERED

□Untreated indication	□ADR	□Delay in switch over from IV to oral
□Improper medicine selection	□Medicine interaction	□Unavailability of medicines
□Sub-therapeutic dose	□Medicine use without indication	□monitoring need
□Overdose	□Duplication of therapy	□counselling need
□Poison		

Appendix 3.13: Interview Schedule

Date …… Respondent Code

Introduction

Let me thank you very much for accepting to participate in this study which seeks to explore the clinical interventions of hospital pharmacists. For the records, can you please confirm that you have read the information sheet and that you are participating voluntarily?

The interview will last between 30-45minutes and we will discuss how clinical interventions are made, the challenges you face and the potential challenges. I may ask you follow-up questions during the discussions and you will also be allowed to ask me any questions after the interview.

Please, be assured once again that the interview will be treated as confidential as possible and no one will have access to transcripts and you will not be linked nor referred to in any report that will be generated from the study.

May I request that you permit me to audio record the conversation so as to enable me analyse it properly. The recordings will be discarded immediately after transcription has been done.

Thank you.

Background & benefits

- Over the past years, you have made a lot of clinical interventions. Briefly describe the clinical interventions you have made.
    - What types of interventions are commonly made
- How beneficial in your opinion have the interventions been
    - HINT: medication safety, preventing harm from reaching patients
- How does one get to be involved in making interventions
- Would you consider these roles as a major role of the pharmacist in the hospital
- How are pharmacists best placed to make these vital clinical interventions

Clinical intervention Process

- Please, describe to me the process you use in undertaking clinical intervention
- How do you document the interventions?
- How do you communicate the interventions?
- How are interventions implemented?
- How do you ensure they are implemented?

Skills and training requirement

- How did you learn how to make clinical interventions
- Were you formally trained to make interventions
- In your opinion, what additional training, in addition to a degree in pharmacy, is required to perform those functions
- How did you develop your skills in performing clinical interventions
- What are your thoughts on the current training for pharmacist on identifying and reporting clinical interventions

Challenges

- What are the current challenges you face in making clinical interventions
- What would you consider are the barriers to performing these tasks
- What do you foresee are future challenges to be encountered by pharmacists in making clinical interventions
- How would you consider the acceptance of other healthcare practitioners to the interventions you make
- How do you think these barriers could be overcome in the future
- How do you think pharmacists can enhance their role in making clinical interventions

- Would you recommend for a nationwide adoption and encouragement of this clinical role of pharmacist

Conclusion

Thank you very much for sharing your thoughts on clinical interventions that you make in the hospital. Lastly, is there any additional information you want to share with me on the subject? If you would want to ask any questions, you may do so now.

Thank you again.

Interviewer:

Appendix 3.14: Participant invitation letter

College of Health Sciences

KNUST

Kumasi

Date……..

Dear Sir/Madam,

INVITATION TO PARTICIPATE IN A STUDY

I am a PhD student undertaking an exploratory study of the Clinical Interventions of Hospital Pharmacists. I am by this letter inviting you to participate in this study.

The World Health Alliance of the World Health Organisation had intimated that including pharmacists in the medication use process results in improve medication safety. Medication safety is also a vital component of patient safety. Increasingly, pharmacists continue to expand their roles. Across the world, this expansion is being given recognition as pharmacists continue to contribute to patient care. In hospitals, pharmacists identify, prevent and report medication errors. The profession of pharmacy, and pharmacists, play a key role in reducing these errors by making appropriate interventions. These reported clinical interventions made by pharmacists would serve as useful information for institutions to be used as safety strategies. This study hopes to understand how clinical interventions are made and the challenges encountered by pharmacists during the process.

This study forms part of a bigger study which has been approved by the Ethical and Protocol Review Committee of the University of Ghana Medical School (MS-Et/M.3 – P 3.1/2013-2014).

Pharmacists who had in the past 3 years reported on clinical interventions made in this hospital are eligible to participate in the study. The study will involve only a 15-20mins interview at your scheduled time and place.

If you are interested in participating, kindly read the information sheet and the consent form that will be provided. Thank you.

You may contact me for further information (0242929622/ franklinach@hotmail.co.uk)

Appendix 3.15: Participant information sheet

PARTICIPANT INFORMATION SHEET

Exploratory study of the Clinical Interventions of Hospital Pharmacists

Researcher: Franklin Acheampong (PhD student)

Kindly accept my appreciation for taking time to read this is information accompanying a consent form for research participation. It contains important information about this study and what to expect if you decide to participate. Please consider the information carefully. Feel free to discuss the study with your friends and family and to ask questions before making your decision whether or not to participate. If you do not understand anything about the study, you may contact the researcher either personally, through email or via phone.

Introduction

Medication safety is a vital component of patient safety. Increasingly, pharmacists continue to expand their role in ensuring the safe use of medicines. Across the world, this expansion is being given recognition as pharmacists continue to contribute to patient care. In hospitals, pharmacists identify, prevent and report medication errors. These reported clinical interventions serve as useful information in preventing future occurrences.

This study hopes to understand how clinical interventions are made and the challenges encountered by pharmacists during the process. You are being asked to participate because you have reported clinical interventions in the past.

Participating in the study

Your participation is voluntary. You may refuse to participate in this study. If you decide to take part in the study, you may leave the study at any time. No matter what decision you make, there will be no penalty to you and you will not lose any of your usual benefits. Your decision will not affect your employment status, your future relationship with the investigator nor his university.

You may or may not benefit as a result of participating in this study. Also, your participation may result in unintended effects for you that may be minor or may be serious and that are due to natural causes.

You will be provided with any new information that develops during the study that may affect your decision whether or not to continue to participate. If you decide to participate, you will be asked to sign a form and will receive a copy of the form.

This study will involve a 30-45mins interview at your scheduled time and place. The interview will be audio recorded, transcribed and analysed. If you choose to participate in this study, you will be asked to describe the clinical intervention process. You will then be asked to provide your views on the challenges faced and the potential future challenges.

We do not anticipate any harm during the interview. You will be assigned an identification number that will be recorded on your respective transcripts. Your name will not be recorded on any of these documents in order to protect your privacy. Thus, your data will be anonymous. The data collected from you will be stored in a database to which only the researcher will have access. The recordings will be destroyed immediately after completion of the researcher's PhD.

Benefits of the study

You will not however be paid for participating in the study. However the study will lead to a better understanding of the topic under discussion. It is hoped that the outcome will be communicated to managers of health institutions in Ghana to explore the possibility of enhancing pharmacists' role in identifying and reporting clinical interventions. The overall goal of this research is to improve patient safety. It is our hope to publish and/or present at national and international level so all information gained is shared widely. You may request a copy of any resultant publication if you are interested by emailing the researcher.

There will also be no costs to you for participating in this study. If you suffer an injury from participating in this study, all efforts will be made obtain medical treatment for you. The cost for this treatment will be billed to you or your insurance.

Confidentiality

Efforts will be made to keep the study-related information confidential unless a demand is placed on the researcher by law to do otherwise. The interviews are confidential and the data collected will be anonymised by the researcher. There will be no way of linking information disclosed back to you in any research report.

Discontinuation of study

If you choose to participate in the study, you may discontinue participation at any time without penalty or loss of benefits. By signing the consent form, you do not give up any personal legal rights you may have as a participant in this study. You will be provided with any new information that develops during the course of the research that may affect your decision whether or not to continue participation in the study. You may refuse to participate in this study without penalty or loss of benefits to which you are otherwise entitled.

Contacts

For questions, concerns, or complaints about the study you may contact the following:

1. Franklin Acheampong, (0242929622 OR Email: franklinach@hotmail.co.uk), Department of Clinical and Social Pharmacy, Faculty of Pharmacy and Pharmaceutical Sciences, Kwame Nkrumah University of Science and Technology

2. Dr Berko P. Anto (Email: berkopanyin@hotmail.com) Department of Clinical and Social Pharmacy, Faculty of Pharmacy and Pharmaceutical Sciences, Kwame Nkrumah University of Science and Technology

Thank you for taking time to read the information sheet. Participation of this study is entirely voluntarily.

Kindly find attached the consent form. Please read it and sign if you decide to participate.

Appendix 3.16: Consent form

CONSENT FORM

Exploratory study of the Clinical Interventions of Hospital Pharmacists

Researcher: Franklin Acheampong (PhD student)

Kindly read the consent form carefully and sign below if you agree to participate in the study. You are free to contact the researcher for more information at any time.

Please answer the following and then sign.

YES / NO. I have read this form and I am aware that I am being asked to participate in a research study.

YES / NO. I have had the opportunity to ask questions and have had them answered to my satisfaction.

YES / NO. I am not giving up any legal rights by signing this form.

YES / NO. I will be given a copy of this form.

YES / NO. I voluntarily agree to participate in this study.

Name of Participant……Signature……

Date……

Researcher ……..Signature ……

APPENDIX 3.17: Inter-Rater Agreement Analysis

Item	Kappa (κ)	p-value
Do you interact with pharmacist in your work?	0.894	<0.001
How satisfied have your interactions with pharmacists in your practice?	0.783	<0.001
Do you get pharmacist to contribute to medication use in your practice?	0.780	<0.001
How often are you satisfied with their contribution?	0.925	0.005
Do you think the collaboration with pharmacists has enhanced drug related patient safety?	0.858	<0.001
Do you think pharmacists are a reliable source of clinical drug information?	0.802	<0.001
Would you consider pharmacists actions as being very patient centred?	0.833	<0.001
Would you like to continue to work with pharmacists to enhance medication safety?	0.912	<0.001
Provide patient education on their medicines	0.788	0.001
Monitor effectiveness and side effects of patients' medication	0.755	<0.001
Recommend drug therapies to physicians	0.783	<0.001
Intervene to prevent prescribing and administration errors from reaching patients	0.835	<0.001
Design and monitor patients pharmacotherapeutic regimes	0.894	<0.001
Write refill prescriptions for existing therapies	0.843	0.002
Provide discharge counselling on medication use	0.800	<0.001
Treat ailments of common occurrences	0.765	0.002
Participate constantly and effectively with physician teams	0.774	<0.001
Reconstitute I.V preparations for administration	0.828	0.003
Dispense medication	0.864	0.031

Report on medication errors and adverse drug reactions	0.845	<0.001
Actively provide reliable drug information to other healthcare professionals	0.900	<0.001
Assist prescribers in selecting appropriate medications	0.858	0.003
Take responsibility for resolving drug-related problems	0.902	0.001
Knowledgeable drug-therapy experts	0.839	<0.001
Provide patient medication education	0.773	<0.001
Use their knowledge and skills to alter drug regimes in the best interest of patients	0.841	<0.001
More patient oriented professionals than just dispensers and compounders of medication	0.960	<0.001
Assist in designing hospital-specific therapeutic protocols for various diseases	0.900	0.023
Assist in selecting cost effective drug therapies	0.867	0.004

APPENDIX 3.18: Recruitment Script For Doctors

Good morning,

My name is Franklin Acheampong and I am a PhD student of the Faculty of Pharmacy and Pharmaceutical Sciences, KNUST. I have joined your clinical meeting this morning because I need your candid contributions to a study I am undertaking in this hospital as part of the project for my course. I have and will be visiting other departments too.

Medicines form a vital part in healthcare. In the medication use process comprising of prescribing, dispensing and administration, there are challenges. A review of the literature also suggests that there are a lot of strategies that have been successful in reducing these challenges. Chiefly among them is the immense contribution pharmacists make to medication safety efforts in hospitals. Health institutions will improve their medication use when they can harness the medication safety activities of pharmacists. In hospitals, these pharmacists do not work alone. They need the support and collaboration of other health care professionals, especially doctors and nurses. It is thus important for us to know the experiences, views, perceptions and expectations you have about working with pharmacists in these safety efforts. It is our belief that the acknowledgement and knowledge of the skills of pharmacist by you doctors will contribute to the safety efforts. These are the things we are interested in finding and we are very grateful for the opportunity.

I would at this time ask you to fill the questionnaire provided which will last between 10-20 minutes and return it to me now. For further clarification on the whole project, you can contact me after the meeting for my phone number/email. While you're reading over the questionnaire, I would like to answer any questions you may have about the study.

Let me take this opportunity to thank you all once again for your participation.

APPENDIX 3.19: Letter of Invitation to Participate

Dear Colleague

There are different medication safety strategies that have been employed with their attendant challenges. However, pharmacists do play a vital role in the medication use process. Pharmacists play these clinical roles with other healthcare professionals and their collaboration is essential in these patient safety efforts. The opinions of these partners have influences on the success of such roles. We are interested in learning your perspectives on pharmacists' role and obtain suggestions on how to enhance their patient care support in the hospital. We sincerely appreciate your input on this topic.

We are by this, inviting you to kindly participate in this study. It is fully voluntary and the questionnaire should be filled unanimously. The information will solely be used for research purposes and treated as confidential as possible. You may stop filling it at any time if you wish not to and there will be no consequences. It will take between 10-20minutes to complete the form and when it is done, kindly fold it and staple it if possible and keep it for collection.

Thank you.

For further information, kindly contact me on 0242929622/ franklinach@hotmail.co.uk

APPENDIX 3.20: Survey Questionnaire

KINDLY FILL THE FORM

1	You are a physician□	You are a nurse□
	□House officer □Senior house officer □Medical officer □Senior Medical officer □Resident □Senior Resident □Specialist □Consultant	□Staff nurse □Senior staff nurse □Nursing officer □Senior nursing officer □Principal Nursing officer □DDNS

2	You are □ Female □ Male	Please, state how long you have practiced	

3	Your current area of practice is
	□Internal medicine □Emergency □Surgery □EYE □ E.N.T □Obstetrics & gynaecology □Paediatrics □ Polyclinic □Others (state): ……
4	Do you interact with pharmacist in your work?
	□Always □ Sometimes □Rarely □Not at all
	How satisfied have your interactions with pharmacists in your practice? Please, tick (√)
	□Very satisfied □ Satisfied □Neutral □ Dissatisfied □ Very dissastisfied
	For what reasons did you interact with pharmacists?(Please, select as many as apply)

4b	□ Seek for drug information □ Drug availability challenges □ Patient drug therapy queries □ Side effects & adverse drug reactions reports □ Discuss patients' medication use
	Please, provide other reasons for your interactions that have not been stated above …… …… …… …… ……

5	Question (Please, tick)√	Always	Sometimes	Rarely	Not at all
	Do you get pharmacist to contribute to medication use in your practice?				
	How often are you satisfied with their contribution?				
	Do you think the collaboration with pharmacists has enhanced drug related patient safety?				
	Do you think pharmacists are a reliable source of clinical drug information?				
	Would you consider pharmacists actions as being very patient centred?				
	Would you like to continue to work with pharmacists to enhance medication safety?				

6	To what extent do you agree with the following activities as the roles of pharmacist in the hospital? Tick(√)	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
	Provide patient education on their medicines					
	Monitor effectiveness and side effects of patients' medication					
	Recommend drug therapies to physicians					
	Intervene to prevent prescribing and administration errors from reaching patients					
	Design and monitor patients pharmacotherapeutic regimes					
	Write refill prescriptions for existing therapies					
	Provide discharge counselling on medication use					
	Treat ailments of common occurrences					
	Participate constantly and effectively with physician teams					
	Reconstitute I.V preparations for administration					
	Dispense medication					
	Report on medication errors and adverse drug reactions					
	Actively provide reliable drug information to other healthcare professionals					

7	My expectations of the future professional roles of pharmacists in hospitals should be. Please, tick(√)	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
	Assist prescribers in selecting appropriate medications					
	Take responsibility for resolving drug-related problems					
	Knowledgeable drug-therapy experts					
	Provide patient medication education					
	Use their knowledge and skills to alter drug regimes in the best interest of patients					
	More patient oriented professionals than just dispensers and compounders of medication					
	Assist in designing hospital-specific therapeutic protocols for various diseases					
	Assist in selecting cost effective drug therapies					
10	Provide any additional roles you think Pharmacists should play in future					

Thank you for your participation.

APPENDIX 3.21: Component Factor Analysis by Varimax Rotated Loadings

Rotated Component Matrix[a]

	Component			
	1	2	3	4
Provide patient education on their medicines	.819	.147	.060	.005
Monitor effectiveness and side effects of patients' medication	.841	.075	.133	.035
Recommend drug therapies to physicians	.630	.087	.282	-.068
Intervene to prevent prescribing and administration errors from reaching patients	.743	.176	.089	.041
Design and monitor patients pharmacotherapeutic regimes	.750	.141	.257	.108
Write refill prescriptions for existing therapies	.283	.048	.742	.244
Provide discharge counselling on medication use	.781	.127	.156	.170
Treat ailments of common occurrences	.266	.042	.790	.091
Participate constantly and effectively with physician teams	.779	.285	-.065	.172
Reconstitute I.V preparations for administration	.296	.200	.087	.722
Dispense medication	.038	.126	.104	.754
Report on medication errors and adverse drug reactions	.757	.276	.035	.232
Actively provide reliable drug information to other healthcare professionals	.814	.206	.014	.115
Assist prescribers in selecting appropriate medications	.079	.755	.164	.124
Take responsibility for resolving drug-related problems	.042	.713	.204	.247
Knowledgeable drug-therapy experts	.238	.765	.076	.029
Provide patient medication education	.204	.711	-.066	.182
Use their knowledge and skills to alter drug regimes in the best interest of patients	-.103	.535	.517	-.206
More patient oriented professionals than just dispensers and compounders of medication	.220	.800	-.017	-.020
Assist in designing hospital-specific therapeutic protocols for various diseases	.247	.784	-.016	.050
Assist in selecting cost effective drug therapies	.242	.781	.009	.094

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.