DISPENSING ERRORS OF UNIT DOSE DRUG DISTRIBUTION SYSTEM AT CENTRAL PHARMACY OF PENANG HOSPITAL

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BY

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Dedicated to

My great beloved mother Siti Elbanat

&

My eight years old lady princess Safia

Who's their precious, kind, and love support let this work out

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LIST OF ABBREVIATIONS

Abbreviation	Description
ASHP	American Society of Hospital Pharmacists
USA	United state of America
ADEs	adverse drug events
IOM	institute of medicine
NCC MERP	American national coordinating council for medication error reporting and prevention
USP	United State Pharmacopoeia
CPOE	computerized physician order entry
JCAHO	joint commission on accreditation health organization
UK	United kingdom
vs.	Versus
UDC	Unit dose cart
CRW	cardio recovery ward
CCU	coronary care unit
GICU	general intensive care unit
C8	Medical cardiology ward
C7	Medical nephrology ward
C6, and C5	general medicine wards 6 and 5
C18	ENT wards (otolaryngology)
SPSS	Statistical Package for the Social Sciences program
ANOVA	Analysis of variance
t-test	Student's t test

TMD	total number of dispensed medications
TMDE	total number of medications dispensing with errors
p-value	Probability statistical measure for the level of significance
SD	standard deviation
DE	dispensing errors
x^2	Chi-Square test for independence
df	Degree of freedom
Freq	Frequency
yrs	Years
Sig.	Significant
CVS	Cardiovascular System
GIT	Gastro intestinal system
CNS	Central Nervous System
RAS	renin angiotensin system
Ca	Calcium
K	Potassium
L- Thyroxin	Levo- Thyroxin
B12	Methylcobalamine
B6	Pyridoxine
B1	Thiamine
Pyridostigmine Br	Pyridostigmine Bromide
mg/kg	milligram per kilogram
HCl	Hydrochloride
USP-MERP	United State Pharmacopoeia medication error reporting program

KESALAHAN PENDISPENSAN DI SISTEM DISTRIBUSI DRUG UNIT DOS DI PUSAT FARMASI HOSPITAL PULAU PINANG

ABSTRAK

Kesalahan pendispensan (DE) adalah kesalahan pengubatan yang biasanya terjadi di bahagian atau perkhidmatan farmasi sebelum pengubatan di bekalkan atau di berikan kepada pesakit. Hasil daripada kajian DE boleh di gunakan sebagai penunjuk mutu pengubatan yang di bekalkan daripada sistem distribusi drug perkhidmatan farmasi. Kesalahan pendispensan perlu dielakkan kerana ia boleh memberi kesan kepada status kesihatan pesakit, komplikasi dan jangka masa tinggal di hospital. Hospital Pulau Pinang telah melaksanakan sistem distribusi drug unit dos bagi mengurangkan kesalahan pengubatan. Satu kajian prospektif dan pemerhatan telah di jalankan di Pusat Farmasi, Hospital Pulau Pinang selama enam bulan bagi mendapatkan data demografi ciri-ciri pesakit, insiden DE, kelas farmakologi drug, jenis-jenis pengubatan yang terlibat dan faktor risiko. Sejumlah 2,254 laci-laci daripada troli pengubatan yang di penuhi dengan 12,283 pengubatan yang di preskripsikan kepada pesakit di wad perubatan telah di kaji. Daripada. 2,254 laci yang di kaji, 560 daripada nya (24.8 %) adalah DE. Lima ratus dan enam puluh laci ini mengandungi 800 pengubatan yang ada DE. Insiden DE berasaskan jumlah bilangan pengubatan (12,283 ubat) adalah 6.5%. Ini bermakna ketepatan pengisian atau pendispensan adalah 93.5 %. Jenis DE yang paling kerap adalah ubat tidak didispenskan (31.0 %), diikuti kesalahan kekuatan dos (23.0 %), mendispens pengubatan yang tidak di preskripsikan (13.1 %), ketidaksuaian label pengubatan (12.2 %), kesalahan jarak pendosan (10.8 %), salahkira bilangan dos (6.1 %), kesalahan bentuk dosej (1.9 %) dan kesalahan jangkamasa (1.9 %). Pengubatan yang tidak didispenskan kerapkali melibatkan drug kardiovaskular khususnya metoprolol (penghalang beta) dan

perindopril (perencat enzim penukaran). Pesakit lelaki, pesakit berumur lebih 40 tahun dan preskripsi lebih daripada lima drug lebih terdedah kepada DE. Faktor risiko lain termasuklah bilangan ubat yang dipreskripsi dan bentuk dosej juga kerapkali terdedah kepada DE. Unit penjagaan koronari (CCU) and wad rehabilitasi coronari (CRW) adalah lokasi yang kerap terdedah kepada DE. Peratus DE yang didapati dari kajian ini adalah dalam julat yang didapati daripada kajian-kajian tempatan tetapi lebih tinggi daripada kajian antarabangsa yang terdahulu. Perbezaan dalam insidens DE mungkin ada kaitan dengan kaedah kajian, definisi, skop dan teknik mengesan DE yang di gunakan. Kesimpulannya kadar insiden DE adalah dianggap ketara di Pusat Farmasi, Hospital Pulau Pinang terutama preskripsi yang ada banyak ubat-ubat. Disarankan yang sistem pemeriksaan berganda yang berkesan, mendispen setiap 12 jam dan bukannya 24 jam dan menyediakan bekas-bekas ubat yang sesuai (mengelakan percampuran dan tersalah mengambil ubat-ubat semasa pengisian pengubatan ke-dalam laci-laci ubat) boleh mengurangkan lagi DE.

DISPENSING ERROR OF UNIT DOSE DRUG DISTRIBUTION SYSTEM AT CENTRAL PHARMACY OF PENANG HOSPITAL

ABSTRACT

Dispensing error (DE) is the medication error which normally occurred at pharmacy site or service before medications supply or administer to patients. Findings from DE study are used as indicator to determine the quality of the drug supply from drug distribution system of the pharmacy services. DE should be avoided because it may affect patient's health status complications and prolong hospital stay. Penang Hospital implemented the unit dose drug distribution system in order to reduce medication errors. An observational prospective study was conducted at Central Pharmacy of Penang Hospital for six months to determine data on patients' demographic characteristics, incidence of DE, pharmacological classes of drugs and types of medications involved and also the risk factors. A total of 2,254 cassettes from medication trolleys which filled with 12,283 prescribed medications for inpatients of medical wards were evaluated. Out of 2,254 cassettes evaluated, 560 cassettes (24.8 %) were found to have DE. These 560 cassettes consisted of 800 medications that have DE. The incidence of DE based on the total number of medications (12,283 medications) was 6.5%. This is mean that the accuracy of filling or dispensing was 93.5% The most common types of DE were undispensed medications (31.0 %), followed by wrong dose strength (23.0 %), unauthorized drug (13.1 %), inappropriate medication label (12.2 %), wrong dose interval (10.8 %), dose miscount (6.1 %), wrong dosage form (1.9 %), and wrong duration (1.9 %). Undispensed medications most frequently involved are the cardiovascular drugs and specifically metoprolol (beta blocker) and perindopril (angiotensin converting enzyme inhibitors). Male patients, patients aged over 40 years old and prescriptions with more than 5 drugs were frequently subjected to DE. The other risk factors were

number of medications and dosage form that also frequently subjected to DE. Coronary care unit (CCU) and coronary rehabilitation ward (CRW) were the most frequent locations involved with DE. The percentage of DE found by this study was within the range of the findings from local studies but higher than previous international studies. The difference in DE incidence may be related with the differences in the method of study, definition, scope, and technique used to track DE. In conclusion, the incidence of DE is considered significant at Central Pharmacy of Penang hospital, particularly prescription with many medications. It is recommended that an effective double checking system, dispensing medications every 12 hours a day instead of a 24 hours and providing a proper medication containers (avoid medications mixed up and wrong picking of medications when filling the medication cassettes) would further minimized DE.

CHAPTER 1

INTRODUCTION

1.1 Medication errors overview

Medication error is a hard topic to assess. It is generally directed at seeking blaming people and does not provide system improvement opportunities with a view to preventing failures (Reason, 2000). The huge quantities of new drugs exploding in the marketplace make it difficult and impossible for physicians, nurses and pharmacists to keep updated with their latest information concerning the indications, contraindications, drug interactions and adverse effects associated with each new drug. Moreover, all medications have side effects, and rare but potentially fatal side effects are unlikely to show up in preliminary clinical trials (Peth, 2003). Medication errors result from the use or misuse of medications, are the most common problem trouble patient safety. Although medication errors are an old issue in healthcare practice, it is only recently globally focused (Neale *et al*, 2001). The therapeutic use of drugs and drug administration devices were associated with inherent risks. These risks caused incident or hazards that have been defined as drug misadventuring. Drug misadventure includes both adverse drug reactions and medication errors (Manasse, 1989). Medication errors occurred as a result of the speed and complexity of the medication use cycle (Williams, 2007). The occurrence of errors in different social and professional systems is result of systematic errors thus medication errors are considered human errors (Manasse, 1989). Medication errors represent a severe social and health problem with important economic influence (Barber & Dean, 1989). The occurrence of medication errors during medication use process were common during prescribing, administration, transcribing and dispensing (Bates, *et al*,

1995 [a / b] & Leape, *et al*, 1995). A total of 4% of all inpatients are exposed to some type of medication errors (Ferner & Aronson, 2000). Medication errors are considered as a valuable learning exercise on the road to a zero-defects system. The hospital management normally avoids taking punitive action against individuals involved in medication errors, because punitive action discourages reporting of error events, and many valuable learning chances from errors however will be lost (Peth, 2003). Number of deaths from medication errors had increased. The increase in numbers of deaths due to medication errors were more than doubled between 1983 and 1993 (Philips, *et al*, 1998). Although it is difficult to ensure drugs are dispensed accurately, it is also so hard to ensure their safety in the absence of an error-free medication system when or after drugs are given to patients (Ishimoto, *et al*, 2003).

The pharmacy service section is responsible for the safe and efficient use of medications in hospitals. It plays an essential role in integrating the prescription, dispensing and administration processes. It is the responsibility of the hospital pharmacy services to establish policies and procedures to minimize and or prevent errors. Since the rate of errors is considered one of the best indicators of quality of medication distribution systems and is still used to evaluate the safety of these systems (Flynn *et al*, 2003). Dispensing errors usually associate with inefficient dispensing system safety (Bohand, *et al*, 2009). Hence pharmacy department can be a vital element in healthcare setting success which reflected in its patient health (Vermeulen, *et al*, 2007). Medications dispensing process that usually happens in hospital pharmacy have been recognized as a source of medication errors and potential adverse effects. Therefore, applying of appropriate dispensing system is considered an important tool to prevent and reduce medication errors, and also minimizes dispensing errors opportunities (Bohand, *et al*, 2009 [a / b]). Accordingly, in

1960 the American hospital pharmacists developed the unit dose drug distribution system in order to reduce medication errors rates, drug costs, losses, thefts and improving the health professional productivity and healthcare quality (Taxis ,*et al*, 1999; Anacleto, *et al*, 2005; Murray & Shojania, 2001; Barker , *et al*, 1963 & ASHP sourcebook on unit dose drug distribution systems, 1978) .

1.2 Error

Error as a word has different meanings and usages relative to how it is conceptually applied. The concrete meaning of the Latin word error is wandering or straying. The difference between error and mistake is that error is being known as a deviation from accuracy or correctness and a mistake is being known as an error caused by a fault which is being misjudgment, carelessness, or forgetfulness. As, there are several definitions for the word error(s) but the most appropriate definition in relation to medical point of view is defined as an act that through ignorance, deficiency, or accident departs from or fails to achieve what should be done. In general error was defined as the failure of a planned action to be completed as intended this is known as error of execution, or the use of a wrong plan to achieve an aim which is known as error of planning (Levy, 2008 & Hofer, *et al*, 2000).

1.3 Medical error

Medical error as a subject appeared in USA in 1990 when states government sponsored research undertaken by Lucian Leape and David Bates about the medical error problem which is defined as an imperfect medical service. The imperfect medical service might result in adverse drug events but some of medication errors might not result in an adverse event (Bates, *et al*, 1995 [a / b]). Medical errors are categorized into adverse drug events (ADEs), potential adverse drug events and medication errors (Morimoto, *et al*, 2004).

Medical errors are totally deferent from malpractice. The latter is the result of negligence, irresponsible ignorance, or criminal intent. While the former is regarded as honest mistakes or accidents and can include:

1. Diagnostic errors: error in diagnosis.
2. Medication errors: errors in the administration of drugs and other medication errors.
3. Performance Errors: such as error in the performance of surgical procedures, in the use of other types of therapy, in the use of equipment and errors in the interpretation of laboratory findings.

1.4 Medication use process

Medication use process is a complex process that includes a series of steps such as medication prescribing and order processing, transcribing and documentation processing, dispensing, administration, effects and monitoring (Peth, 2003). The safe medication use process should ensure dispensing of right drug, with the right dose and route, at the right time accurately reached the right patient (Cohen, 1999). During the medication use process steps there is a high opportunity to medication errors occurrences. Accordingly, medication errors have been classified into prescribing, transcribing, dispensing and administration errors .Each step of this process could lead to medication errors (Trapskin, *et al*, 2006 & Peth, 2003). The occurrences of this error may or may not lead to an adverse drug event.

The capability of medication use process must be evaluated to reduce the injuries caused by medication errors, and to reduce hazards that patients are exposed to (Peth, 2003). The evaluation of medication use process in most health systems is the basic responsibility of the pharmacy and therapeutic committee (Lombardi, 2000). The evaluation of medication use process in any healthcare settings resulted in

an estimation of medication error per day per patient with respected to variation in error rate between healthcare facility settings (Yeh, *et al*, 2007 & Williams, 2007). The American National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) adopted a policy that recommended medication error prevention in the medication use process and also recommended correction and avoiding error prone aspects in this process, these recommendation are applied through modification of system, practice standards and guidelines in all healthcare (US Pharmacopoeia quality review, 2000).

1.5 Definition of medication error

Medication error definition depend on research methodologies, incident reporting, risk management, or total quality improvement systems (NCC MERP). It is also broadly defined as any error in the prescribing, dispensing, or administration of a drug, irrespective of whether such errors lead to adverse consequences or not (Williams, 2007). According to patient outcome, medication errors defined as 'a failure in the treatment process that leads to, or has the potential to lead to, harm to the patient'. This definition; work with the approach to the classification of medication errors according to whether they are mistakes, slips, or lapses (Williams, 2007).

Also it is defined as an act that through ignorance, deficiency, or accident departs from or fails to achieve what should be done. What should be done is generally known as "the five rights": the right drug, right dose, right route, right time and right patient (Cohen, 1999; Gerson, 1980 & Barker, *et al*, 1966). Medication Error is defined as any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer. Such events may be related to

professional practice, healthcare products, procedures and systems, including prescribing; order communication; product labeling, packaging and nomenclature; compounding; dispensing; distribution; administration; education; monitoring and use (NCC MERP).

Drug dispensing is defined as an act entailing the interpretation of an order for a drug or biological and, pursuant to that orders the proper selection, measuring, labeling, packaging and issuance of the drug or biological for patients or for a service unit of the facility. Dispensing errors are any deviations from original prescriber orders (Gerson, 1980).

1.6 Types of medication errors and its definition

Types and definitions of medication errors don't varies greatly from study to another, for example in an Indian study about medication errors types ; drug-drug interactions, incorrect dosing interval and dosing errors were the most frequently occurring types of error (Pote, *et al*, 2007). Other studies mentioned many medication errors types such as patient received medication not ordered or medication ordered but not given, wrong drug, wrong dose, wrong or inappropriate drug, wrong administration technique, wrong route, wrong dosage form, wrong time, error related to patient information, wrong frequency, transcription, wrong patient, illegible order and wrong date (Marcin, *et al*, 2007; Kaushal, *et al*, 2001; Bates, *et al*, 1995 & Allen La Pointe & Jollis, 2003). Dosage errors, incorrect interval, drug duplication and drug interaction are also consider as medication error (Vrca, *et al*, 2005)

Types of medication errors identified at medication use process stage are prescription errors which include wrong drug, wrong dose, wrong route and wrong frequency errors; dispensing errors which include wrong drug, wrong strength,

wrong quantity and wrong label errors; and administration errors which include wrong drug, wrong dose, missed dose and wrong frequency errors (Karnon, *et al*, 2007). Improper dose, wrong drug and dose omission are also consider as medication errors which are identified during medication use process stages (Haw, *et al*, 2005), Table 1.1 illustrates the types of medication errors and their definitions.

Table 1.1: Types and definition of medication errors

Type	**Definition**
Omission error	The failure to administer an ordered dose to a patient before the next scheduled dose, if any.
Wrong time error	Administration of medication outside a predefined time interval from its scheduled administration time.
Unauthorized drug error	Administration of medication not authorized by a legitimate prescriber for the patient. Also included a wrong drug, a dose given to the wrong patient, unordered drugs and doses given outside a stated set of clinical guidelines or protocols.
Improper dose error	Administration to the patient of a dose that is greater than or less than the amount ordered by the prescriber or administration of duplicate doses to the patient, i.e., one or more dosage units in addition to those that were ordered.
Wrong dosage-form error	Administration to the patient of a drug product in a different dosage form than ordered by the prescriber.
Wrong drug-preparation error	Drug product incorrectly formulated or manipulated before administration such as incorrect dilution or reconstitution, mixing drugs that are physically or chemically incompatible and inadequate product packaging.

(American Society of Hospital Pharmacists, 1989 & 1993; American Society of Consultant Pharmacists, 1997; Lesar, *et al*, 1990; Cohen, 2000; & Ito & Yamazumi, 2003).

1.7 Medication errors classifications

Medication errors are classified according to either their occurrence at which stage of medication use process or according to their severity of patient outcome, or whether they are mistakes, slips, or lapses (Williams, 2007; Aronson, 2009 & Fortescue, *et al*, 2003). Friedman et al (2007) classified medication errors into prescription error, delivery error, availability error, patient error and reporting error.

1.7.1 Medication use cycle and medication errors classifications

According to the occurrence of errors at any stage of medication use process medication errors are classified into prescribing errors, dispensing errors, medication administration errors and patient compliance errors (American Society of Hospital Pharmacists, 1993; Barker & Allan, 1995; Kaushal, *et al*, 2001; Flynn, *et al*, 2003 & Karnon, *et al*, 2007).

1.7.1(a) Prescribing errors

Dean and Schachter (2000) defined prescribing errors as a clinically meaningful prescribing error which occurs as a result of a prescribing decision or prescription writing process. There is an unintentional significant reduction in the probability of treatment being timely and effective or increase in the risk of harm when compared with generally accepted practice. It was estimated that 1-2 % of US inpatients are harmed by this type of medication errors (Dean, *et al*, 2000). Many other studies In US carried hospital identified prescribing errors. Early studies report that the prescribing errors occurred in 0.4 – 1.9 % of written medication orders (Folli, *et al*, 1987 & Blum, *et al*, 1988). It was also found that about 71 % of serious medication errors were been tracked and happened at prescribing stage (Senst, *et al*, 2001). Recent study reported that the majority of medication errors occurred in USA is due to poor prescribing (Williams, 2007). This type of error occurred at

prescribing stage and caused harm to the patient, and it's involved inaccurate prescribing such as improper dose, route of administration and frequency Dean, *et al*, 2002 [a / b]). Also this error involved prescribing of inappropriate medication or duplication of medication which may lead to the administration of wrong dose sometimes. Prescribing error is being life-threatening if decimal point is placed inaccurately and this type of error is considered a potentially fatal error. Another form of prescribing error is inappropriate or inadequate instructions for use of a medication ordered by a physician (Barber, *et al*, 2003 & Lesar, *et al*, 1997). Recent study to evaluate computerized physician order entry (CPOE) on medication errors in a Portugal Internal Medicine Department using unit-dose distribution system was carried out. It was found that the most common prescribing errors was deficiencies related to the right class but wrong drug, incorrect dose and unclear orders (Mirco, *et al*, 2005)

Prescribing errors are mostly associated with lack of knowledge about the drug prescribed and also lack of knowledge regarding the patient for whom the drug is prescribed (Beers, *et al*, 1990 & Lesar, *et al*, 1997). As a policy to reduce prescribing errors; hospitals should apply training programs to junior doctors before they start prescribing. Also hospital should enforce good documentations, accurate prescription writing and formally review interventions made by pharmacists (Dean, *et al*, 2002 [a / b]).

1.7.1(b) Transcribing errors

Transcribing errors resulted due to breakdown in communication between the prescriber and the person dispensing or administering the medication such as an oral order misinterpretation or ambiguous order (Peth, 2003). Also transcribing errors include problems associated with the use of calculations, decimal points, unit or rate

expression, drug name sound a like and nomenclature factors, such as incorrect drug name, dosage form, or abbreviation (Peth, 2003). These types of errors are 100 % preventable but constitute a serious breakdown in the system of medication use process. This type of medication errors can be eliminated by electronic medical records and e-mail prescriptions (Peth, 2003). The implementation of computerized physician order entry (CPOE) eliminated or reducing the opportunity for transcribing errors (Mirco, *et al*, 2005; Walsh, *et al*, 2005 & Wang, *et al*, 2007). In one study nurses reported 141 medication administration errors during the study period, 21 % out of these error cases were order writing and transcribing errors (Ford, *et al*, 2006).

1.7.1(c) Dispensing errors

Dispensing of medication is an integral part of the quality use of the medicines and together with the patient counseling forms the core professional activities of a pharmacist. Dispensing errors occur during the medication dispensing process despite the efforts to prevent them. (Flynn *et al*, 2003 & Allard, *et al*, 2002) The stage of medications dispensing is the last chance to correct a medication error occurred during prescribing and transcribing stages concurrently. Pharmacists play vital role in correcting these errors before reaching inpatients and outpatients (Folli, *et al*, 1987 & Blum, *et al*, 1988).

Dispensing errors generally refers to as an error that was done by pharmacy staff during physician order processing. The main risk factors that were identified associate with the dispensing errors were found to be prescription overload, lighting levels, noise, interruptions and distractions.

1.7.1(d) Administration errors

Administration errors originated during medication administration process at the nursing unit. Administration errors occur when either the wrong drug is

administered, or the right drug is administered in the wrong dose or via the wrong route, or with an incompatible co administered drug. It may also occur when the right drug is given to the wrong patient (Thomas, *et al*, 1999). Administration errors occurrences can cause serious potentials harm to patients, especially when they occur via the intra venous (IV) route (Peth, 2003). As in dispensing stage, administration stage may also be the last chance to apply important safety checks to prevent a medication error. Many administration errors occur due to lack of critical safety checks which might be ignored because there is a rush to administer the drug especially in emergency cases (Peth, 2003).

1.7.1(e) Monitoring errors

Failure to review a prescribed regimen for appropriateness, or failure to use appropriate clinical or laboratory data for adequate assessment of resident response to prescribed therapy.

1.7.2 Classification of medication errors according to patient outcome severity

National Coordinating Council for Medication Error Reporting and Prevention classified medication errors into categories. These categories are classified from A to I. The three main broader categories, are category (A) which refer to errors having the potential to cause harm , (B to D) errors that cause no harm, and (E to I) errors that are harmful to patient

1.7.2(a) Medication errors categorizing index

NCC MERP created an index classification system which is a part of American medication errors taxonomy. This system classified error according to the patient outcome severity. This scale index was classified to factors such as whether error reached patient, and if reached patient whether error caused harm and to which degree which might help healthcare system policy makers to track medication errors

in a consistent, systematic manner (NCC MERP, 1996; 2001 & Hartwig, Denger *et al*, 1991; Cohen & joint commission on accreditation (JCAHO), 2008 & Guchelaar, *et al*, 2005).

1.7.2(b) Medication errors algorithm

Medication errors algorithm is a tool developed by NCC MERP. This algorithm was created to help healthcare professionals to identify error type and categorize patient outcome severity so this helps them to decide which category is the most appropriate for the event under consideration**,** which resulted in assisting and easing the process of analyzing of medication errors and so enhance tracking and reporting of it. (NCC MERP & Hartwig, *et al*, 1991 ; American society of health system pharmacists (ASHP); Cohen & joint commission on accreditation, 2008; Portnoy, *et al*, 2004; & Mayhall, 2004).

1.8 Severity of medication errors

It is difficult to draw the clinical impact of medication errors. Previous studies assessed the potential clinical significance of the prevented and observed errors identified by the researchers. The American institute of medicine's (IOM) in the 1999 report stated "To Err is Human: building a safer health system". It was estimated that between 44,000 and 98,000 people die in America as the result of preventable medical errors. (Levy, 2008 & Kohn, *et al*, 2000) Medication errors contribute significantly to the total number of overall medical errors and deaths associated with preventable medical errors. IOM reported that, more than 7,000 Americans die annually from medication errors when subjected to healthcare. Medication errors are often caused by series problems of system complexity (Levy, 2008 & Neale *et al.*, 2001). Hospital pharmacy services were a source of medication errors and potential adverse drug events (Cina, *et al*, 2006). Medication errors as a

failure might accompany every stage of the drug delivery process, dispensing errors as a type of medication errors usually associate with poor safety and inefficient dispensing systems (Bohand, *et al*, 2009 [a / b]). Occurrences of dispensing errors can potentially harm patients by causing adverse drug events (Poon, *et al*, 2005).

Medication errors represented one type of the many types of medication related problems, which occurred at all steps of medication use process, commonly occurred at prescribing and administration steps (Cohen, 2000).

1.9 Causes of medication errors

Medication errors are multidisciplinary and multifactorial problem (Benjamin, *et al*, 2003; Davis & Cohen, 1981 & Zellmer, 1990). It occurs as a result of lack of knowledge, substandard performance and mental lapses, or defects or systems failures (Davis & Cohen, 1981 & Zellmer, 1990). Experienced and inexperienced professional staff of healthcare setting committed medication errors. Healthcare professional staffs include pharmacists, physicians, nurses, supportive personnel (e.g., pharmacy technicians), students, clerical staff (e.g., ward clerks), administrators, pharmaceutical manufacturers, patients and their caregivers and others (Manasse, 1989 & ASHP, 1992).

Traditionally medication errors occurrence were referred to as someone's fault or human error (Manasse, 1989 & Leape, 1994). This situation was just concentrated on blaming, not going further to dig and discover the causative root factors of these errors. Nowadays system approach is concentrated on the errors as a consequent rather than a cause, this organization system approach seeks to develop a protection mechanism to prevent or minimize the consequences of the errors (Reason, 2000). In USA, IOM considered the shift from human approach towards

system approach as the biggest challenge towards a safer health system (IOM USA, 2001).

Medication errors occurred due to a number of most common reasons (American Society of Hospital Pharmacists, 1993, Ashcroft, *et al*, 2005, Beso, *et al*, 2005, Peterson, *et al*, 1999 & Davis, 1981) such as

1. Lack of drug therapy knowledge.
2. Inaccurate dosage calculation
3. Poor drug storage and stocking.
4. Problems with standardization and distribution.
5. Insufficient and inadequate patient information and medication use process and poor communication of drug information.
6. Poor and illegible hand writing and improper transcription.
7. Confusing or misleading drug labeling, packing and nomenclature (such as look-alike or sound-alike names), and ambiguous strength designation on labels or in packaging
8. Poor safety assessment of drug delivery devices before purchase and during their use.
9. Misinterpreted verbal orders and inappropriate abbreviations used in prescribing.
10. Lack of time and excessive heavy workload
11. Lapses in individual performance.
12. Inadequately trained personnel.

1.10 Medication errors prevention

Prevention or reduction of the medication errors to the minimum at any healthcare setting required three types of interventions. These interventions have had

the greatest potential impact on its occurrence. Firstly, the presence of clinical pharmacists, to monitor ordering, transcribing and administering might prevent or minimize errors. Secondly, computerized physician order entry could have prevented a large majority of errors. Thirdly, improved communication between healthcare practitioners might have a significant impact in potential error prevention specifically, physician pharmacist communication and physician nurse communication (Fortescue, *et al*, 2003).

NCC MERP established a strategy to prevent medication errors. The strategy works through different addresses such as error prone aspects of medication use process standardization , system based solutions encouragements to assure medication use safety and minimize the potential for human error , potential computer-based information systems exploration, identifications of specific needs for distinctive packaging, labeling and nomenclature of products associated with actual or potential medication errors and also this strategy addresses educating healthcare professionals, consumers, patients about strategies to prevent medication errors for prescription and over-the-counter medications .

1.11 Literature review

1.11.1 Hospital pharmacy

Hospital pharmacy normally locates within the hospital premises. It stocks a larger range of medications, including more specialized and unlicensed medications. It consists of administrative and clinical features. Clinical pharmacy is the largest part of hospital pharmacy work in which the pharmacist participate in ward rounds. This participation allows them to revise patient drug histories and contribute to the treatment decision-making process. Therefore, they can affect physician prescribing through emphasizing possible side effects, drug-drug interactions and the suitable drug choice for patients conditions (Rodden, 2000).

1.11.2 Role of hospital pharmacists

Hospital pharmacists have many activities such as developing medication policies, selection of drugs which is the essential part of patients care, annual budgeting, procurement from trustable pharmaceutical suppliers sources, manufacturing of pharmaceutical preparations, dispensing of drug to all hospital units ensure appropriate and safe use of medications and monitoring the drug regimen, teaching of nurses and medical and pharmacy interns (house officers) and beside these activities the most important activity is making hospital formulary . All these activities is controlled by qualified, professional and well trained pharmacists (Gerson, 1980)

1.11.3 Services offer by the hospital pharmacy department

The first arm of services offer by the hospital pharmacy department is dispensing services such as drugs supplying processes and related services; this composes of two main options of services that is outpatient dispensing service and inpatient dispensing service. Dispensing services should conform drug therapy eight

rights which are the right medication administers to the right patient at the right time in the right dosing strength using the right dosage form and the right route to administers to achieve desired responses and administered medication rightly record and right response accomplish (Gerson, 1980) .

The other arm is non dispensing services which include two branches. The first one is clinical pharmacy which concerning with rationale use of medications. This is a health science discipline in which pharmacists provide patient care that optimizes medication therapy and promotes health, wellness and disease prevention. The pharmacist uses their expert professional knowledge to counseling patients about the effects of their medicines, dosage and route of administration. The second branch is the drug committee. It includes pharmacist, physicians and other hospital staff. It would help make decision concerns drug. (Gerson, 1980)

1. 12 Types of hospital distribution system

Drug distribution systems vary in the type of packaging and the number of total days of dosage units supplied which varied from a 24-hour supply to one month supply. Drug distribution systems classified to two categories traditional and unit dose (Gerson, 1980).

1. Individual prescription order system usually found in small private hospitals. This system required small number of staff. Its advantages are that all medications orders are directly verified and dispensed by pharmacists. This lead to pharmacist, physician, nurse and patient interaction. The disadvantage is delayed dispensing.
2. Floor stock system classified drugs / medications into charge and non charge items which would be found in general governmental hospitals. The advantage of this system is that are available stocks in the nurse units so no

delaying happened when medication is needed. The nurse dispenses medications and the pharmacy act as central procurement store. The disadvantage of this system is that it is usually association with medication errors, medication wasted, theft and lack of known pharmaceutical storage conditions.

3. Combination of individual prescription order and floor stock.
4. Ward stock system and a decentralized, patient-orientated, ready-to-use drug distribution system (satellite pharmacy system) also exist.
5. Unit dose system is a technology that distributes all medications to the hospital unit in individual packages that identify its name and dose. All medications are prescribed, repackage, dispensed, administered and charge in single units. Some hospitals dispensed only solid oral dosage forms in single unit packages, the amount of supplied drugs varied from 24 hours - 7 days supply. Medications are_dispensed in ready to administer form. Unit dose drug distributing system is available in two types which are manual and automated system (Gerson, 1980 & Fulton and Allen, 2005).

1.13 Dispensing medications

Dispensing medications involves many steps. The first step is receiving written original or verbal orders from authorized physicians. The order include: patient full name, demographic information's (age, weight and gender), hospital entry number or registration number, allergy history, pre-existing conditions, admission diagnosis and ward. The ordered medications must include drug name, dosage form and strength, route of administration, doses intervals and durations (length of therapy). Hospital approved standard abbreviations must be used if there is any need to write medication orders in abbreviate form.

The second step in dispensing medication is screening and verifying of the prescription within the pharmacy patient medication profiles which contain concurrent medication in use. Pharmacist verifies prescriptions for any needed accurate clarifications and to assure completeness. This step is held to compare patient therapy data with new ordered prescriptions so as to predict and prevent drug related problems and correct any inappropriateness.

The third step in dispensing medication is preparing, filling and checking of single unit dose medication cart by pharmacy technicians. Finally, the final accuracy check is carried by pharmacist to assure appropriate drugs are mounted in individual patient cassette. After the final accuracy check the unit dose cart will be pulled out from pharmacy department to the wards.

1.14 Dispensing errors

Hospital pharmacy dispensing is an important part of medication use process. It needs very careful and full attention to ensure that dispensed medications comply with the physician written prescriptions, which lead to a reduced possibility of errors (Anacleto, et al, 2007). This is one of the main professional role of hospital Pharmacists through this role they should perform an essential part to correct a prescription errors for inpatients and outpatients (Peth, 2003 & Teinila, et al, 2008). The hospital Pharmacists must also assure that medication use process for inpatient is safe and efficient. Some studies dealing with system approach believes that system failure will lead to the occurrence of errors. The hospital pharmacy should be responsible for setting a functioning protocol to prevent errors and to assure accurate efficient medication use process for inpatient, because pharmacy services play an essential role in the prescription, dispensing and administration processes, (Costa, et al, 2008 & Teinila , et al, 2008). This will result in avoiding patient poor quality

outcomes and the pharmacist achieving a desirable professional results by completely eliminate interruption or incorrect of dispensing process step sequence completion (Peterson, 1999).

Medication errors and patient safety publications increase in number since the past decade (Teinila, et al, 2008) and after IOM report in November 1999 that “to Err is human: building a safer health system” , in1995 Bates and colleague published their study about medication errors frequency evaluation through a multidisciplinary approach where they identified 5.3 errors for each 100 orders. They also determined that only few (0.9%) of medication errors resulted in adverse drug events (Bates, et al, 1995 a / b). Despite of the definitions and methods used would ease comparison of a wide range of research studies (Teinila, et al, 2008 & Ellen, 1999), it has been noticed that medication errors literature lacks well known universally and approved definitions as well as a unique particular methods and criteria to tackle and to investigate the problem of medication errors worldwide. However most of medication errors studies differ basically in setting, design, quality and results. These factors leave every researcher confused with an incomplete knowledge of the actual rate of medication errors (Lisby, *et al*, 2005).

Many researchers believed that the use of information technology such as computerized physician order entry (CPOE) with clinical decision support has been shown to capture medication errors and significantly reduce the serious ones in the adult hospital setting (Wang, *et al* , 2007). David Williams mentioned that the two reports concurrently released by the National Patient Safety Agency and the Institute of Medicine both emphasized that medical errors cause a large number of deaths each year and that is between 44,000 and 98,000 patients deaths each year in the USA (Williams, 2007; Abdullah, *et al*, 2004; Peth, 2003 & Longo, *et al*, 2007).

Attention to medication and dispensing errors was intensified after a report issued by of IOM that encourage the implementation of a safety systems in healthcare organizations to ensure convenient, efficient and safe practices of medication use process (Szeinbach, *et al*, 2007).

Previous studies such as a study done by Anacleto *et al* (2005) consider that dispensing errors were failure usually occurred as a result of a leakage in one of the last safety stage of drug use process that could represent dispensing errors, which reflect poor safety and inefficient dispensing systems. Another study mentioned that dispensing errors could be corrected if documented and evaluated as a part of quality improvement (Knudsen, *et al*, 2007[a / b]).

1.15 Methodological design and hospital setting

Most setting used the descriptive cross-sectional study. Recent study using this method was carried out at a pharmaceutical service in a Brazilian pediatric hospital (Costa, *et al*, 2008). The earlier studies used the before-and-after comparison. This study method is used when a hospital introduces or implements new system such as unit dose system, bar code and physician computer order entry (Bates, *et al*, 1998). A direct observation prospective study is also one of the methods used to detect dispensing errors. An example is a direct observation prospective study conducted in the central pharmacy and cardiovascular department in a French military hospital for two months (Bohand, *et al*, 2009 [a / b]). Study periods used also varied and it depends on hospital setting. Most of the studies done to track dispensing errors had various time frames that are from weeks to several months.

1.16 Dispensing errors definitions

Most of the researchers defined medication errors using the definition by NCC MERP where by medication error is define as: "Any preventable event that

may cause or lead to inappropriate medication use or patient harm, while the medication is in the control of the healthcare professional, patient, or consumer. Such events may be related to professional practice, healthcare products, procedures and systems including prescribing; order communication; product labeling, packaging and nomenclature; compounding; dispensing; distribution; administration; education; monitoring and use."

Medication error is also defined as a discrepancy between the dose ordered and the dose received (Carothers, 1998; Teinila, *et al*, 2008 & Barker, *et al*, 2002). It was also defined as any discrepancies between dispensed medications and physician orders, or replenishment requests or any deviation from standard pharmacy policies or any inconsistencies from the prescription order (Poon, *et al*, 2006 & Szeinbach, *et al*, 2007). Dispensing errors occur when a patient is given a medicine which was not intended by the prescriber. Errors occur when the dispenser knows what to do but for some reason does not do it. They also happen when they do the wrong things which seem good at that time.

Any deviation from the medical prescription in dispensing medication was considered a dispensing error and it occur during the medication dispensing process (Costa, *et al*, 2008). Dispensing errors research held in hospital pharmacy setting focused on errors identified at the final check stage before medications left the pharmacy, or on errors identified after medications has left the department (Beso, *et al*, 2005). Medication errors define as errors occurring at any step of the dispensing stage from when pharmacy department receive prescriber orders till dispensed medicine to the patient (Williams, 2007).

1.17 Incidence of dispensing errors

Dispensing errors rate reflect the quality of medication distribution systems. It is used as an indicator to evaluate their safety. Some studies showed a 10% incidence of dispensing errors in hospitals applying unit doses distribution system. A few Brazilian studies were carried out on dispensing errors presented rates of errors above 10% (Costa, *et al*, 2008). Studies held in the community pharmacies in USA reported up to 24% of dispensing error rates and 12.5% in outpatient hospital pharmacies, despite wide differences in the methods and definitions used (Beso , *et al* , 2005). Few studies about dispensing errors were conducted to identify errors at the final check stage in UK hospital pharmacies. These studies reported error rates at the final check stage range from 0.2% to 0.7% of all dispensed items. However these rates may be underestimated due to little detail on the methodology and definitions used (Beso, *et al*, 2005). Dispensing errors studies carried out in the community and hospital pharmacies in the UK and the USA reported error rates from 0.018% - 24%, despite the wide difference in the dispensing error definitions and the methods used among these studies, incidences of medication error rates vary widely, due to the variation of definitions and different study methods used. The rate of medication errors between patients admitted to hospital varies from 2 to 14%, and is associated with 1–2% of patients being harmed as a result in the USA the incidence rate of dispensing errors in UK is similar that is between 1and 24 percent (Williams , 2007). It is thus difficult to compare results between different studies, because of different methods used to evaluate and detect dispensing errors (Costa, *et al*, 2008).

1.18 Types of dispensing error

The types of dispensing errors also varied according to setting and method used. Dispensing errors studies held in the community and hospital pharmacies in the

UK and the USA showed that error of contents were the most common types of dispensing errors. Error of contents includes incorrect drug, incorrect dosage form, incorrect quantity or incorrect strength of a drug (Teinila, *et al*, 2008). The wrong strength or medication, wrong dose, wrong drug, or wrong patient are also types of dispensing errors (Williams, 2007).

1.19 Reasons behind the occurrence of dispensing errors

Recent study showed that the pharmacy system is considered as a significant factor leading to dispensing errors (Szeinbach, *et al*, 2007). Many causative factors in the pharmacy system can lead to dispensing errors. A heavy workload and the look a likes of drug packages were the most potential causes of the dispensing errors (Teinila, *et al*, 2008). Another study done in USA in a community pharmacies setting also conclude that dispensing of potentially clinically drug-drug interactions were related to a higher pharmacist workload (Malone, *et al*, 2007). Medication errors resulted from the speed and complexity of the medication use process, and also resulted from slips in attention (Williams, 2007). Inaccurate, unclear inter relationship and communications among medication use process professional staffs, deficits in knowledge and performance, medication mix-ups and look alike and sound alike drug names contribute to dispensing errors (Carothers, 1998; 1999).

1.20 Drug classes observed in dispensing error literature

Studies have showed that various different classes of drugs are involved in dispensing error. The most important classes were showed in a study done in U.S.A to track incidence and preventability of adverse drug events among older persons in the ambulatory setting. The researchers identified dispensing errors causing preventable adverse drug events of <2% and the most common medication classes involved were cardiovascular medications (24.5%), diuretics (22.1%), nonopioid