INTRODUCTION

Medications are the most common type of therapy in intensive care units (ICUs) and are also associated with the most frequent type of ICUs adverse events. Critically ill patients are at high risk for adverse drug events for many reasons, including the complexity of their disease that creates challenges in drug dosing, their vulnerability to rapid changes in pharmacotherapy, the intensive care environment providing ample distractions and opportunity for error, the administration of complex drug regimens, the numerous high alert medications that they receive, and the mode of drug administration. The clinical outcomes of adverse drug events can result in end-organ damage and even death **(Kane-Gill, Jacobi & Rothschild, 2010)**.

Along with institute of safe medication practice (ISMP), the Institute of Healthcare Improvement (IHI) and the Joint Commission recognizing the life-threatening risks associated with high alert drugs and high priority to safeguarding their use is given its hospital accreditation standards. The Joint Commission requires hospitals to "develop processes for managing high alert drugs." After first identifying medications that pose the greatest risk, a hospital should then develop safe processes for procuring, storing, ordering, transcribing, preparing, dispensing, administering, and monitoring them and multiprofessional patient care team to promote patient safety in the ICU **(JC, 2009)**.

One of the 12 interventions that IHI recommends for its 5 Million Lives Campaign is prevent harm from high alert medications, starting with a focus on the four groups of high alert medications (anticoagulants, narcotics and opiates, insulin, and sedatives). The most common types of harm associated with these medications include hypotension, bleeding, hypoglycemia, delirium, lethargy, and bradycardia **(McCannon, Hackbarth & Griffin, 2007)**. High alert medications can also be linked to other care processes and campaign interventions, such as medication reconciliation, care of the ventilated patient (deep venous thrombosis prophylaxis), and preoperative care. In some cases, rapid deterioration of a patient may be caused by, or aggravated by, medications **(Federico, 2007)**.

Nurses' perceptions of medication errors vary in relation to causes and the reporting of medication errors included illegible handwriting, and staffing by distracted and exhausted nurses **(Mayo & Duncan, 2004)**. Less than half (45.6%) of nurses believed that all drug errors are reported. Increasing their knowledge of medications and medication administration without changing complicated and intricate systems may be more efficient. An educational programme can raise nurses' awareness about medication errors and other medications related safety issues **(Elnour, Ellahham & Al Qassas, 2008)**. Lack of pharmacology teaching and a theory practice gap can lead nurses to make administration errors **(King, 2004)**.

The nurses' performance deficit and insufficient knowledge play a prominent role in drug errors. In ICUs, performance level failures accounted for 53% of the errors **(Rothschild, Keohane & Cook, 2005)**. Nurses' insufficient knowledge is considered to be one of the most significant factors contributing to medication administration errors. Nurses' self reported administration errors showed that unfamiliarity with medications was the third most significant contributing factor among eight categories. Nurses' calculation skills (e.g. decimal points, or unit and rate expressions) and nomenclature factors such as incorrect drug name, dosage form or abbreviation **(Tang, Sheu, Yu, Wei & Chen, 2007)**.

System errors, such as a critical shortage of healthcare professionals, increased numbers of high acuity patients, multiple complex technologies, increased pressure to reduce costs at the same time as demands to improve quality of care, and the use of high alert medications with a narrow therapeutic index, have all contributed to an error-prone environment **(Hicks, Becker & Krenzischeck, 2004)**. To avoid incorrect selection of drugs and reduce variation in drug administration processes, various strategies such as centralization, standardization and simplification of process have been suggested for high alert medications **(Anderson, 2010; ISMP, 2010)**.

Significance of the study:

The clinical outcomes of adverse drug events due to high alert medication can result in end organ damage and considered the fourth to sixth leading cause of death. The costs of an adverse drug event can be substantial to healthcare systems with an additional $6,000 –$9,000 for each event **(Kane-Gill, Jacobi & Rothschild, 2010)**. The Taiwan Joint Commission on Hospital Accreditation (TJCHA) set the avoidance of medication errors as its first priority among ten goals for hospital safety, as medication errors were the leading cause among 13 types of medical negligence and between 6000 and 20,000 deaths were due to medication adverse events **(TJCHA, 2010)**. The third goal on the Joint Commission National Patient Safety Goals (JCNPSG) is to improve the safety of using high alert medications **(JC, 2009)**. In Egypt, by reviewing statistical data there are no statistical documents related to administration of high alert medication and administration errors not available.

AIM OF THE STUDY

The present study aims to assess nurses' performance regarding intravenous infusion of high alert medication.

Research Questions:

- What is the level of nurses' knowledge regarding intravenous infusion of high alert medication?
- What is the level of nurses' attitude regarding intravenous infusion of high alert medication?
- What is the score of nurses' practice regarding intravenous infusion of high alert medication?

REVIEW OF LITERATURE

Definition of Medication:

A drug is any substance that alters physiologic function, with the potential for affecting health. A medication is drug administered for its therapeutic effects. Thus, all medications are drugs, but not all drugs are medications **(Craven & Hirnle, 2009)**.

Overview of Pharmacology Concepts:

A sound of knowledge of basic pharmacologic principles is essential if the nurses are safely administering medications and to monitor patients who receive these medications. Knowledge and awareness of nurses with respect to the effects, adverse effects and methods of administration of drug, could help to evaluate the quality of pharmacology in hospitals **(Hajebi, 2010)**. Pharmacology is the scientific study of medicine and biology concerned with origin, nature, chemistry, effect, and use of drugs. The science is made up of five branches: pharmacodynamics, pharmacokinetics, pharmacotherapeutic, toxicology, and pharmacogenosy **(Vallance & Smart, 2006)**.

Pharmacokinetics refers to activities within the body after a drug is administered. Pharmacokinetics is divided into several areas including the extent and rate of absorption, distribution, metabolism, and excretion. This is commonly

referred to as the ADME scheme: Absorption - the process of a substance entering the blood circulation. Distribution - the dispersion or dissemination of substances throughout the fluids and tissues of the body. Metabolism (or Biotransformation) - the irreversible transformation of parent compounds into daughter metabolites. Excretion (or Elimination) is the elimination of the substances from the body. In rare cases, some drugs irreversibly accumulate in body tissue. Another pharmacokinetic component is the half life of the drug. Half-life is the measure of rate at which drugs are removed from the body **(Ruiz-Garcia, Bermejo, Moss &Casabo, 2008; Anne & Kimble, 2009)**.

Pharmacodynamics is the study of the biochemical interaction and physiological effects of drugs on the body and the mechanisms of drug action and the body cells to produce biological reaction and the relationship between drug concentration and effect, it may be local or systematic **(Lees, Cunningham & Elliott, 2004; Craven & Hirnle, 2009)**. The Pharmacodynamics phase include the primary effect of drugs which is desired or the therapeutic effect, the secondary effects are all other effects, whether desirable or undesirable, produced by drugs which are drug reaction, drug- drug interaction and drug food interaction **(Anne & Kimble, 2009)**.

The pharmacotherapeutic is desired and international effects, which vary with the nature of medication, the length of time the patient has been receiving it and the patient physical

condition. The drug reaction and any effects other than the therapeutic effect which include the adverse drug reaction, allergic drug reaction, drug tolerance, a cumulative drug effect, toxic reaction and pharmacokinetic reaction. The drug-drug interaction occurs when one drug interacts with or interferes with the action of another drug, it include; additive drug reaction, synergistic drug reaction, antagonistic drug reaction **(Anne & Kimble, 2009; Craven & Hirnle, 2009)**.

Drugs have a specific kind of nomenclature throughout the process of development; drugs may have several names assigned to them (the chemical name, the generic (nonproprietary) name, and a trade or brand name). This is confusing unless the nurse has a clear understanding of the different names used **(Anne & Kimble, 2009)**. The chemical name is the chemist's term which describes constitutes that make up its molecular structure and the placement of atoms or atomic grouping. The official name is assigned by United States adopted from council usually this name is generic (nonproprietary) name which is simpler than chemical name and not capitalized (e.g. morphine sulfate). The trade or brand name is assigned by the manufacturer, brand names are nouns with first letter capitalized and designated with a circled R (®) **(Craven & Hirnle, 2009)**.

There are certain factors that influence drug responses and that nurses must consider before administration of medication. These factors include age, weight, gender, disease,

and route of administration. Nurses must be familiar with the calculation of all forms of medication dosages; there are three system of measurement of drugs dosages: the metric system, the apothecaries system, and household measurements (**Anne & Kimble, 2009)**.

In certain situations the proper administration of medication depends on the nurse's ability to compute medication doses accurately and measure medications correctly. A careless mistake in placing a decimal point or adding a zero to a dose can lead to a fatal error. The nurses are responsible for checking the dose before giving medication. Most nations use the metric system as a standard of measurement, in the metric system the gram is the unit of weight, the litter is the unit of volume, and the meter is the unit of length. For medication calculation the nurses use only the volume and weight units in which the capital letter is used to designate basic units (e.g. Gram = g or Gm & Liter = l or L) and lowercase letter is used for abbreviation for other units (Milligram = mg & Milliliter = ml) **(Taylor, Lillis & Lamina, 2008)**.

High Alert Medications

"Drugs bear a heightened risk of causing significant patient harm when they are used in error". Although mistakes may or may not be more common with these drugs, the consequences of an error are more devastating to patients **(ISMP, 2012)**.

The Institute for Safe Medication Practices (ISMP) listed 19 classes or categories of medications (and 14 specific medications) considered high alert **(ISMP, 2007)**. The American Pharmaceutical Association has listed eight high alert medication categories: cardiovascular drugs, vasopressors agents, chemotherapeutic agents, narcotics, opiates, anticoagulants, benzodiazepines, neuromuscular blocking agents, insulin and electrolytes **(Cohen, Smetzer, Tuohy & Kilo, 2007)**. The United King National Patient Safety Agency (UKNPSA) stated that the most frequently responsible drugs of medication administrative errors were norepinephrine, insulin and morphine **(Thomas & Panchagnula, 2008)**.

The Unites States Pharmacopeia Institute for Safe Medication Practices Medication Errors Reporting Program (USP ISMP MERP) has created a list of 33 drugs and drug categories considered to be potential high alert medications. This may include strategies like limiting access; using auxiliary labels and automated alerts; standardizing the ordering, concentrations, preparation, and administration of these products; using premixed solutions; and employing automated or independent double-checks when necessary **(ISMP MERP, 2012)**.

The ISMP's list of error-prone abbreviations, symbols, and dose designations have been found and reported to ISMP through the ISMP Medication Error Reporting Program (MERP) as being frequently misinterpreted and involved in

harmful medication errors. They should NEVER be used when communicating medical information. This includes internal communications, telephone/verbal prescriptions, and computer-generated labels, labels for drug storage bins, medication administration records, as well as pharmacy and prescriber computer order entry screens **(ISMP MERP, 2012)**.

Despite advances in technology, policy, and practice and at least 10 years of focused effort to prevent the drug name confusion among health care professionals and patients over drugs with similar-looking and similar-sounding names remains an elusive goal. Multiple factors cause drug names to be confused. There are four basic types of errors; visual perception errors, auditory perception errors, and short-term memory errors **(Lambert, Lin & Toh, 2005)**, and motor control errors **(Kushniruk, Triola, Borycki, Stein & Kannry, 2005).**

The Food and Drug Administration (FDA) approved established an alphabetized list of look-alike drug names with recommended tall man letters, which were first identified during the FDA Name Differentiation Project **(Gerrett, Gale, Darker, Filik & Purdy, 2009)**. The tall man letters (i.e., capital letters) have received the most attention which shown that highlighting sections of drug names using tall man letters can help distinguish similar drug names, making them less prone to mix-ups. Using of the capital letters to distinguish similar names from one another increased accuracy in a task

that incorporated elements of visual recognition and recognition memory, neither upper-case letters nor color was effective in reducing recognition memory errors **(Filik, Purdy, Gale & Gerrett, 2006)**.

The ISMP, FDA, The Joint Commission, and other safety-conscious organizations have promoted the use of tall man letters as one means of reducing confusion between similar drug names. To promote standardization, the ISMP has created a list of look-alike drug name sets with recommended tall man letters **(National Association of Boards of Pharmacy, 2008; ISMP, 2012)**.

The complexity of dosing and monitoring of these high alert medications augment the risk of errors. Doses are individualized, based on weight or other laboratory parameters, often involving a calculation and then titrated based on subsequent laboratory values. Common errors involve incorrect dose calculation, subsequent failure to set the IV pump correctly, and failure to monitor **(Federico, 2007)**.

Compounding of IV infusions leads to the potential for error, whether performed by the nurse or by a pharmacist, especially if he/she is not specifically trained in that skill **(Parshuram, 2008; Valentin, Capuzzo & Guidet, 2009)**. Electrolyte errors have occurred at the ordering stage (failure to specify salt); preparation stage; and administration stage (related to frequent doses and inadequate monitoring; too rapid

administration; concurrent administration of incompatible salts, such as calcium and phosphate; or failure to replace a needed electrolyte) **(Wheeler, Degnan & Sehmi, 2008)**.

Standardizing high risk IV infusion medication administration, concentrations, and limiting the dose units available in patient care areas will reduce the risk of medication errors or minimize their consequences should an error occur. Intravenous infusion medications have the greatest potential for causing significant patient harm. IV medications are frequently associated with dosage errors during administration due to confusion created by the variety of available drug concentrations and dosage units. The Indianapolis Coalition for Patient Safety chartered a task force to standardize intravenous medication concentrations and dosage units for safer and more consistent practices in administering high alert IV medications to patients. It was assumed that standardization would decrease the potential for medication errors **(Knotts, 2009)**.

Lack of standardization has been at least a partial cause of many cases of overly high doses, including a number of fatal overdoses **(Schneider, 2005)**. Substantial unnecessary variation in IV medication practices is associated with increased risk of harm; standardization has the potential to substantially improve IV medication safety **(Bates, Vanderveen, Seger, Yamaga & Rothschild, 2005).** The JCAHO National Patient Safety Goal requires a hospital to

improve the safety of using medications, standardize and limit the number of drug concentrations available in the organization **(JCAHO, 2005)**.

Extensive variability exists in drug dosing units, and selection of the wrong dosage unit can result in very large errors; for example, although most hospitals use only one concentration of heparin, they frequently use more than one dosage unit for heparin (e.g., units/hr and units/kg/hr) in the same patient care area. This creates opportunities for significant errors (e.g., a 68-kg patient could receive a 68-fold overdose) (**Bates et al., 2005)**.

A standard approach to IV medications exists in many hospitals. But often the standard is not the same across all areas in a hospital, or across all or even most hospitals in a given region where patients and staff may transfer. Policies, procedures, and standard work processes can provide a substantial margin of safety in minimizing variability in high risk situations. Importantly, technology is not required to implement standardization of IV drug concentrations and dosage units. For institutions that do have or plan to implement smart pumps, standardization of drug concentrations and dosage units is an important first step in creating the necessary drug libraries. Standardization of drug dosing ranges is a logical next step in improving medication safety **(SDPSC, 2006)**.

Medication Errors

Any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems are including; prescribing, order communication, product labeling, packaging, and nomenclature compounding, dispensing, distribution, administration, education, monitoring, and use **(NCC MERP, 2007; 2009)**. The medication administration errors are one of the most common causes of avoidable harm to patients in health care organizations **(JCAHO, 2010)**.

Medication error data were collected in a standardized format through a series of required and optional fields. Part of the standardized format includes NCC MERP's definition of a medication error, as well as its Index for Categorizing Medication Errors. USP refers to this index as the Error Category Index: This single select field captures whether a medication error occurred, and if it occurred, its effect on the patient. In NCC MERP's Index for Categorizing Medication Errors: Category A, represents circumstances or events that have the capacity to cause error. Category B, indicates that a medication error occurred but it did not reach the patient (i.e., intercepted). Categories C and D, were designating medication errors that reached the patient but did not result in patient