**DRUG CALCULATION SKILLS AND ASSOCIATED FACTORS AMONG NURSES IN FEDERAL MEDICAL CENTER UMUAHIA, NIGERIA**

**ABSTRACT**

This study examined the drug calculation skills and associated factors among nurses in Federal Medical Centre, Umuahia in south-eastern Nigeria. This cross-sectional study was conducted in January-April 2023. To evaluate the drug calculation skills and associated factors among nurses. A sample of 187 nurses was selected using simple random sampling technique. Data were collected using the Adult Infusion Dose Calculation Quiz (AIDCQ) for Nurses designed by the researcher. Collected data were summarized and analysed at 5% level of significance. Results demonstrated that the respondents who had adequate ability in stating the correct formula for drug calculation was 81.1%. About 52.2% were able to state the correct macro drip set of 20 drops per ml while 47.8 % stated a wrong macro drip set factor of 15 drops per ml. About 91.9% could not arrive at the correct drip flow rate. There was no significant association between educational qualification of nurses and their drug calculation skills (χ2 **=** 13.92, df = 15, p = 0.532). The respondent nurses have good theoretical knowledge of drug calculation formula but were highly prone to errors in drug calculations involving macro drip sets. In recommendation, more training on infusion therapy and drug calculation should be organized by nurses for update of practice.

***Key Words:*** *Drug dosage calculation, educational status, adult, Nigeria*

**CHAPTER ONE**

**INTRODUCTION**

**Background to the study**

Drug calculation skills are an important part of nursing care (Paa-Kofi-Tawiah et al., 2022). Nurses must be able to accurately calculate dosages of medication, as well as understand the ramifications of giving a patient the wrong dosage (Joseph et al., 2022). Nurses need to be familiar with different measurement systems, such as metric and imperial systems as well as keep up with the latest trends in drug calculation to ensure patient safety (Guido et al., 2019).

Patient safety is a vital aspect of nursing, which nurses ensure by following patients' medication instructions (de-Oliveira et al., 2018; Smith 2019; take-Nilsson et al., 2022). One of the most prevalent issues in modern medicine is drug calculation (Williams & Davis, 2016). Many of the mistakes are preventable and pose a danger to patient safety (Yousef & Yousef, 2017). These mistakes can have a wide range of implications for patients, from the loss of a medication's good benefits to death. Apart from ethical concerns, medication calculation mistakes can lead to increased healthcare costs (Gustafson & Karen-Mercereau, 2016). Medication calculation mistakes cost at least 20 billion dollars each year.

Medication mistakes occur in one out of every five doses in a normal hospital and have been recognized as the most prevalent form of error influencing patient safety as well as the most common single avoidable cause of adverse outcomes (Soon et al., 2021). Mathematical mistakes have been linked to 11-14% of pharmaceutical errors (Mulac et al., 2021). While drug administration is primarily the job of nurses, both doctors and nurses have been found to make mistakes when calculating drug dosages (Wennberg-Capellades et al., 2022). Given that the administration of some pharmaceuticals necessitates a lot of difficult calculations, mathematical competence and proficiency are required (Khasawneh et al., 2020). To acquire correct medicine doses, two mathematical abilities are required: the capacity to compute mathematically and the ability to extract important information from accessible clinical information to frame a mathematical calculation to be solved (Collins & Duffy, 2022). The inability to effectively calculate medicine doses has been found to significantly increase the likelihood of making a medication mistake (Kuitunen et al., 2021).

Medication errors that occur in healthcare have been reported to be the seventh most common cause of death globally (Strbova et al., 2015). It accounts for more than seven thousand deaths annually (Fekadu et al., 2017). Intravenously administered medicines and infusions show the highest risk of medication error (Vijaykumar et al., 2014). Medication error is any preventable event that could potentially result in inappropriate medicine use or cause harm to a consumer of healthcare, while the medicine is under the control of a care giver (Bagheri-nesami et al., 2015). More so, these errors may not entirely be due to negligence of practice by the care provider but may also be due to the complicated administration process of intravenous infusions.

Intravenous infusions are frequently given for hospital inpatients, particularly for hydration maintenance. It is necessary for fluid volume replacement and as a medium for parenteral medication transfusion (Patel et al., 2019). It is thus a beneficial medico-nursing intervention for patients with insufficient oral fluid intake and significant fluid loss as shown in vomiting and diarrhoea. Although intravenous infusion is one of the pharmaceutical delivery techniques utilized in hospitals, there is a danger of life-threatening complications when provided in (Fekadu et al., 2017). Intravenous fluid administration is complicated, and current research indicates that mistakes occur at least 55.2% of the time (Lyons et al., 2018). Administration of intravenous infusions must be done as prescribed as too slow or too fast dose delivery rate can be deleterious to the patient. Most of the time, intravenous infusion prescription order is not written in drops per minute (gtts/min). The required drops per minute rate of prescribed infusion are often left for the attending clinician (physician and nurse-midwife) and intern to calculate using the formula: drop rate per minute = ((volume of infusion X drop factor)/(Time duration in minutes)) (Patel et al., 2019). This complexity can prove difficult for clinicians and interns with little mathematical abilities, especially during clinical emergencies. Concerns about patient safety have led to the introduction of error-reducing smart pumps with pre-set drips per minute calibration for controlling intravenous infusion dosage distribution in more sophisticated nations. Moreover, the adoption of error-reduction smart pump technologies with pre-set drips per minute calibration is not popular in underdeveloped nations. Many types of macro drip systems for controlling intravenous infusions are available in European and American literature for use in maternal health clinics (Potter et al., 2017).

The drop factor of the equipment varies depending on the manufacturer and will be indicated on the exterior box of the different varieties of macro drip sets available. There is a possibility of excess or under-delivery of recommended infusion dosage in countries where sources and manufacturer labelling of macro drip sets are not properly monitored. Summa-sorgini et al. (2012) discovered inconsistencies between prescription and observed administration in terms of infusion rate among critical care clinical personnel in this regard (physicians and nurses).

As a result, Potter et al (2017) and Strbova et al (2015) advised doctors to be aware of the kind and drop factor of macro drip sets in use in their clinics, maternity wards, and hospitals.

The drop factor of a drip set is the number of drops in the drip chamber that sum up to one millilitre (1 ml). According to Potter et al. (2017), the drop factor of the most popular macro drip sets ranges from 10gtts/ml (Travenol or Baxter brand) to 15gtts/ml (Travenol or Baxter brand) (Abbott and McGraw brands). Gage and Toney-butler (2019) agreed, adding that macro drip sets had drop factors ranging from 10 to 20gtts/ml. In the same vein, numerous additional Indian and African writers have reported values such as 16gtts/ml (Patel et al., 2019), 15gtts/ml (Diorgu & Robinson-bassey, 2018), and 20gtts/ml (Diorgu & Robinson-bassey, 2018).

**Statement of Problem**

Based on the assumption that the drop factor of available macro drip sets varies, this variance may provide some problem in emergency scenarios if the manufacturer does not clearly disclose the drop factor of the macro drip set.

During a clinical emergency, a practitioner who is unfamiliar with the drop factor of the most widely used macro drip set risks underdosing or overdosing the patient. This occurrence puts the patient at risk of poor treatment-related health outcomes, life-threatening illnesses, and even death (Hertig et al., 2018). Nurses are required to accurately calculate drug dosages for their patients in order to ensure the patient’s safety and well-being. However, due to the importance of this skill, researchers call for frequent drug calculation training and drills for nurse. Therefore, there is a need to examine nurses’ drug calculation skills necessary to provide safe and effective patient care.

**Objectives of the study**

The aim of this study is to evaluate the drug calculation skills and associated factors among nurses in Federal Medical Centre Umuahia, Nigeria.

The specific objectives for the study are to:

1. assess the nurses’ ability to state the correct formula to be used in drug calculation.
2. assess the ability of the nurses to state the correct macro drip set drop factor used in Federal Medical Centre, Umuahia
3. assess the ability of the nurses to arrive at the correct drip flow rate.
4. determine the association between drug calculation skill and the nurses’ educational qualification.

**Research Questions/Hypotheses**

1. What is the nurse’s ability to state the correct formula used in drug calculation?
2. What is the ability of the nurses to state the correct macro drip set drop factor used in Federal Medical Centre, Umuahia?
3. What is the ability of the nurses to arrive at the correct drip flow rate?
4. What is the association between drug calculation skill and nurses’ educational qualification?

The following null hypotheses will be tested:

1. There is no significant association between the nurses’ educational qualification and drug calculation skills.

**Significance of the study**

Drug calculation is an essential skill for nurses, as it is a fundamental part of providing safe and effective patient care. Drug errors can have serious consequences for patients, including death, and nurses need to possess excellent drug calculation skills to protect their patients. The purpose of this study is to evaluate the drug calculation skills of nurses to identify areas in need of improvement. The results of this study will provide valuable information to help nursing educators, employers, and other healthcare professionals to ensure that nurses are receiving the necessary training and skills needed to safely administer medications. By understanding the current state of drug calculation skills among nurses, healthcare organizations can take steps to improve the quality of patient care. This study will also provide important insight into how drug calculation skills can be improved and how nurses can be better supported in their efforts to provide safe and effective patient care. Additionally, the findings of this research could also be used to inform clinical practice guidelines and to help ensure patient safety. By providing an in-depth exploration of drug calculation skills for nurses, this study will be invaluable in helping to improve patient care.

Additionally, possible findings of this study may save money for the government and hospital managements. It would do this by equipping nurses with evidence to avert the burden of litigation that could arise from infusion error.

Furthermore, possible findings from this study would on the long term protect patients, health service consumers and the public from infusion dose error as the nurse becomes more aware of the characteristics of the macro drip/adult drip sets prevalently used in south-eastern Nigeria.

Finally, this study may stimulate further studies on similar topics. It will also serve as reference to other newer empirical studies.

**Scope of the study**

The present study is delimited to nurses in Federal Medical Centre, Umuahia. It will focus on the assessment of drug calculation skills and will be carried out in the year 2023.

**Operational definition of terms**

**Drug calculation skills:** for the purpose of this study, drug calculation skills involve the ability of the respondents to state the correct formula for calculating infusion dosages, the correct macro drip set drop factor of 20 drops per ml and arriving at a mathematically logical drip flow rate. It will be graded as good (3 marks), moderate (2 marks), and poor (0-1 mark)

**Nurses:** for the purpose of this study nurses refer to licensed/registered nurses employed to practice in Federal Medical Centre Umuahia.

**CHAPTER TWO**

**LITERATURE REVIEW**

Related literature was reviewed under conceptual, theoretical, and empirical review.

**Conceptual Review**

**Drug**

A drug is any chemical substance that, when eaten, induces a change in the physiology or psychology of an organism (Guo et al., 2020). Food and substances that give nutritional assistance are often differentiated from drugs (Zhong et al., 2018). Drugs can be consumed by inhalation, injection, smoking, ingestion, absorption through a patch on the skin, suppository, or dissolving beneath the tongue (Pitiot et al., 2022).

A drug is a chemical compound with a recognized structure that, when delivered to a living creature, exerts a biological effect (Lim et al., 2022). A pharmaceutical drug, often known as a medication or medicine, is a chemical compound that is used to treat, cure, prevent, or diagnose a disease, or to improve health (Legesse et al., 2020). Drugs were traditionally obtained by the extraction of medicinal herbs, but more recently through chemical synthesis (Noor, et al., 2020). Pharmaceutical drugs can be used to treat chronic conditions for a brief length of time or on a regular basis (Legesse, et al., 2020). Drug classes are groups of drugs that have similar chemical structures, the same mechanism of action (for example, binding to the same biological target), and a similar mode of action, and are used to treat the same ailment (Schäfer & Wenzel, 2020). The Anatomical Therapeutic Chemical Classification System (ATC), the most widely used drug categorization system, assigns each medicine a unique ATC code, which is an alphanumeric identifier that assigns it to certain drug classes within the ATC system. Another major classification system is the Biopharmaceutics Classification System (Truzzi et al., 2021). This classification system categorizes drugs based on their solubility and permeability or absorption. Psychoactive pharmaceuticals are chemicals that modify the central nervous system's function, affecting perception, emotion, or awareness (Cao et al., 2020). These medicines are classified as stimulants, depressants, antidepressants, anxiolytics, antipsychotics, and hallucinogens (Cao et al., 2020). These psychoactive medications have been shown to be effective in the treatment of a wide range of medical illnesses, including mental disorders, all over the world (Abrams & Guzman, 2015). Caffeine, nicotine, and alcohol are the most extensively used drugs in the world, and they are also termed recreational drugs since they are taken for enjoyment rather than therapeutic objectives (Luethi & Liechti, 2022). Every drug has the potential for side effects. When misused, many psychoactive chemicals can develop into addiction and/or physical reliance (Johnson & Griffiths, 2017). Stimulant psychosis can result from excessive stimulant use (Moran et al., 2021). Many recreational drugs are prohibited under international treaties such as the Single Convention on Narcotic Drugs (Luethi & Liechti, 2022).

**Dose**

A dose is a predetermined amount of medicine, nutrient, or pathogen that is administered as a unit (Pastino & Lakra, 2023). The larger the dose, the greater the quantity delivered. In medicine, doses are most typically determined for substances. The phrase normally refers to the amount of a medication or other agent supplied for therapeutic purposes, but it can also refer to any situation in which a substance is delivered into the body. In nutrition, the phrase typically refers to the amount of a given nutrient in a person's diet or a specific dish, meal, or dietary supplement. Dose often refers to the quantity of pathogen necessary to infect a host in the case of bacterial or viral pathogens. Toxicology is concerned with harmful chemical doses (Campleman et al., 2020). In clinical pharmacology, dose refers to the amount of drug administered to a person, whereas exposure refers to the time-dependent concentration of the drug in the circulatory blood or plasma or concentration-derived parameters such as the area under the concentration curve and peak level of the concentration curve after administration. In other fields, though, they are interchangeable.

**Drug Calculation**

Drug calculation is required when the amount of medication needed differs from what is available (Boyle & Eastwood, 2018). When translating from pounds to kilograms or litres to millilitres, drug calculations necessitate the use of conversion factors. This method's simple design allows practitioners to deal with different units of measurement, converting factors to reach the solution. These approaches are useful for double or triple-testing the correctness of the other ways of computation. A 2016 study evaluated the role confidence plays in overall arithmetic in drug calculation skills. Study participants attended remedial math classes from a wide range of educational backgrounds and age dynamics seeking a first degree in nursing, a foundation degree, or post-registration courses (Shelton, 2016). The study revealed one-third of students feel a lack of confidence, which originated in an earlier stage of education, dating back to a primary school environment (Shelton, 2016). The study concluded that confidence plays a role in dosage calculations and the overall performance of mathematical calculations and can be improved in an environment that fosters a deep-learning approach (Shelton, 2016).

**Desired Formula of Drug Calculation**

Desired over Have or Formula, is a formula or equation used to solve for an unknown variable (x) (Toney-Butler et al., 2023). Conversion factors are used in drug calculations, such as when converting pounds to kilograms or litres to millilitres. This method's simple design allows us to operate with different units of measurement, translating factors to reach our solution. A fundamental formula for solving for x aid in constructing an equation:

D/H x Q = x, or Desired dosage (amount) = ordered dose amount/amount on hand x Quantity.

For example, a practitioner may order lorazepam 4 mg IV push for a patient who is experiencing acute alcohol withdrawal. The doctor has vials of 2 mg/mL on hand.

To provide the required dose, how many millilitres should he or she draw up in a syringe?

Dosage requested (4 mg) x Quantity (1 mL)/Have (2 mg) = Amount desired (2 mL)

Units of measurement must match, for example, millilitres and millilitres, or conversion to similar units of measurement is required (Toney-Butler et al., 2023).

In the above case, the requested dose was in milligrams, and the have dose was also in milligrams, which cancels out to leave millilitres (response called for millilitres), thus no additional conversion is necessary.

**Dimensional Method of Drug Calculation**

If a practitioner orders lorazepam 4 mg IV PUSH with a CIWA score of 25 or higher, follow the CAGE Protocol for the following doses depending on CIWA scoring. The automated dispensing equipment has 2 mg/mL vials for the physician. How many millilitres are required to achieve the desired dose?

Remember, (x mL) = 4 mg/1 x 1 mL/2 mg x (4)(1)/2 x 4/2 x 2/1 = 2 mL, continue multiplying/dividing until the required quantity is obtained, 2 mL in our case.

 The fraction was put up carefully using milligrams to cancel each other out, making the equation easier to calculate for the target unit or millilitres. Work is completed because the answer makes sense. Zeros, like similar units, can be cancelled out.

As an example:

1000/500 x 10/5 = 2, the two zeros in 1000 and two zeros in 500 may be crossed out because they are in the same unit as the numerator and denominator, leaving 10/5, a much easier fraction to calculate, and the solution makes sense. Zeros have been covered, so moving to one. When a number is multiplied by 1, the number remains unaltered. In contrast, multiplying a number by zero results in the number becomes zero (Toney-Butler et al., 2023). The following are some examples:

18 x 0 = 0 or 20 x 1 = 20.

**Ratio and Proportion Method of Drug Calculation**

The Ratio and Proportion Method has been used in medication estimates for many years and is one of the oldest approaches (Toney-Butler et al., 2023).

The principle of addition is a problem-solving method that has no influence on this connection.

To solve a ratio and proportion issue, only multiplication and division are utilized, not addition.

A better understanding will be provided by the following example, which uses a fraction or a colon format:

With a CIWA score of 25, a clinician recommends lorazepam 4 mg IV Push right away.

There are 2 mg/mL vials available. How many millilitres are needed to administer the prescribed dose?

* Have on hand / Quantity you have = Desired Amount / x
* 2 mg/1 mL = 4 mg/x
* 2x/2 = 4/2
* x = 2 mL

One would use H:V::D:X and multiply means DV and Extremes HX in colon format.

* Hx = DV, x = DV/H, 2:1::4:x, 2x = (4)(1), x = 4/2, x = 2 mL

**Infusion/Intravenous medication therapy**

Infusion is a method of administration that delivers fluids directly into the vein. The intravenous route of administration is commonly used for fluid solutions such as rehydration or nutrition in those who cannot consume food or water by mouth. It may also be used to administer medicines, electrolytes, and blood (Fekadu et al., 2017). The intravenous route is the fastest way to deliver medications and fluid replacement throughout the body, as they are introduced directly into the circulatory system. The most basic intravenous access consists of a needle piercing the skin and entering a vein which is connected to tubing outside the body for administration of the desired fluid or medication therapy. Another use of infusion administration is the avoidance of first bypass metabolism of medicines by the liver (Lyons et al., 2018). A substance that may be infused intravenously includes volume expanders, blood-based products, blood substitutes, medications, and nutrition.

Fluids may be administered as infusion for volume expansion or fluid replacement (Potter et al, 2017). Volume expansion consists of the administration of fluid-based solutions or suspensions designed to target specific areas of the body which need more water. There are two main types of volume expanders are crystalloids and colloids. Crystalloids are aqueous solutions of mineral salts or other water-soluble molecules such as isotonic normal saline (0.9% Sodium Chloride) and hypotonic Ringers Lactate (Wasini, 2014). Colloids contain larger insoluble molecules, such as blood and plasma. Furthermore, Buffer solutions which are used to correct acidosis and alkalosis are also administered through infusion such as sodium bicarbonate (Diorgu & Robinson-bassey, 2018). Medication may be mixed into the infusion fluids.

A continuous infusion can be used to correct fluid and electrolyte imbalances, or when it is desirable to have a constant blood concentration of a medication over time (Royal College of Nursing, 2019). Continuous infusions are used where the variation in concentration that arises from gaps in administration would be undesirable, such as antibiotic therapy. They may also be used instead of intermittent bolus injections for the same reason (Potter et al., 2017). Infusions can also be intermittent, in which case the medication is administered over a period, then stopped, and this is later repeated. Intermittent infusion may be used when there are concerns about the stability of medicine in solution for long periods of time (as is common with continuous infusions), or to enable the administration of medicines which would be incompatible if administered at the same time in the same Infusion line. Failure to properly calculate and administer an infusion can result in adverse effects, termed infusion reactions (Royal College of Nursing, 2019). For this reason, many medications have a maximum recommended infusion rate (McMullan et al., 2010).

**Infusion set equipment.**

Equipment used to place and administer an infusion consists of a bag, usually hanging above the height of the person, and sterile tubing through which the medicine is administered and a needle/cannula (Royal College of Nursing, 2019). In a basic gravity Infusion, a bag is simply hung above the height of the person and the solution is pulled via gravity through a tube attached to a needle/cannula inserted into a vein. Without extra equipment, it is not possible to precisely control the rate of administration. For this reason, a setup may also incorporate a clamp to regulate flow. Some Infusion lines may be placed with Y-sites, devices which enable a secondary solution to be administered through the same line (known as piggybacking). Some systems employ a drip chamber which prevents air from entering the bloodstream and allows visual estimation of flow rate of the solution. Alternatively, an infusion pump may be used to allow precise control over the flow rate and total amount delivered (Sultana, 2017). A pump is programmed based on the number and size of infusions being administered to ensure all medicine is fully administered without allowing the access line to run dry. Pumps are primarily utilized when a constant flow rate is important, or where changes in rate of administration would have consequences.

**Macro drip set / Adult drip set.**

Macro drip set is a spike that allows large volumes of fluid to flow from an infusion bag into a collecting chamber and then into a patient, who requires rapid fluid resuscitation. Macro drip sets are used for adults whereas micro drip sets are used for babies. It has a drip chamber which is a device used to allow gas (air) to rise out from an infusion fluid so that it is not passed downstream into a patient (Hertig et al., 2018). The use of a drip chamber also allows an estimate of the rate at which fluid is administered. For a fluid of a given viscosity, drips from a hole of known size will be of nearly identical volume, and the number of drips in a minute can be counted to gauge the rate of flow. In this instance the rate of flow is usually controlled by a clamp on the infusion tubing; this affects the resistance to flow. However, other sources of resistance (such as whether the vein is kinked or compressed by the patient's position) cannot be so directly controlled and a change in position may change the rate of flow leading to inadvertently rapid or slow infusion (Wasini, 2014). Where this might be problematic an infusion pump can be used which gives a more accurate measurement of flow rate.

**Drop factor of drip sets**

Drip chambers can be classified into macro-drip (about 10 to 20 gtts/ml) and micro-drip (about 60 gtts/ml) based on their drop factors (Gage & Toney-butler, 2019). For a given drip chamber (when the fluid drips from the hole into the chamber) drop factor means number of drops per ml of the IV fluid. Flow rate can be calculated with the help of the observations from the drip chamber and its drop factor. The unit of flow rate is gtts/min (Royal College of Nursing, 2019).

The volume of a drop is not well defined: it depends on the device and technique used to produce the drop, on the strength of the gravitational field, and on the viscosity, density, and the surface tension of the liquid (Wasini, 2014). In medicine, Infusion drips deliver 10, 15, 20, or 60 drops per mL. Micro-drip sets deliver 60 drops per mL and 10, 15, or 20 drops per mL for a macro-drip set (Royal College of Nursing, 2019).

**Macro drip infusion delivery dose calculation techniques**

The main formula used for calculation of infusion dose and duration is:

$$ drops per minute =\frac{volume of infusion X drop factor}{Time duration in minutes}$$

So, regarding as example**:** A prescription order reads Rx: infuse 100mls of metronidazole over 50minutes using the adult macro drip of drop factor of 20gtts/ml. At what drop rate (in drops per minute) will you set the infusion? (Clearly Show all working).

Drop rate in gtts/min = (100mls x 20gtts/ml) ÷ 50mins = 40gtts/min

**Skills**

A skill is the taught capacity to operate predictably with effective execution, generally within a limited amount of time, energy, or both. Domain-general and domain-specific abilities are frequently distinguished. In the domain of work, for example, some general skills might include time management, teamwork, leadership, self-motivation, and others, whereas domain-specific abilities would only be utilized for a certain profession.

To measure the amount of skill displayed and employed, specific contextual triggers and scenarios are normally required. When a talent reflects a body of information or a discipline of study, such as the art of medicine or the art of war, it is referred to as an art. Although the arts are talents, numerous skills make up art but have nothing to do with the beautiful arts. To contribute to the contemporary economy, people must have a diverse set of talents. A joint ASTD and US Department of Labour research found that technology is altering the workplace and highlighted 16 essential skills that employees must have to keep up. Three major types of talents are proposed: technical, human, and conceptual. Hard and soft talents can be swapped for the first two.

**Theoretical review**

*Health Belief Model (1988 version)*

The Health Belief Model (HBM) underpins the present study. HBM is a psychosocial model that attempts to explain and predict behaviours. This is done by focusing on the attitude and beliefs of individuals. The health belief model was spelled out in term of four constructs representing the perceived threat and net benefits perceived benefits & perceived barriers. These concepts were proposed as accounting for people’s readiness to act. “An added concept cues to action and self-efficacy or one’s confidence in the ability to successfully perform and action was added by Rosenstock and others in 1988 to help the health belief model better fit the challenges of changing habitual unhealthy behaviour, such as being sedentary, smoking or overeating.

**Perceived severity:** Perceived severity refers to the subjective assessment of the severity of a health problem and its potential consequences. The health belief model proposes that individuals who perceive a given health problem as serious are more likely to engage in behaviours to prevent the health problem from occurring. (Or reduce its severity). Perceived seriousness encompasses beliefs about the disease itself. (e.g., whether it is life-threatening or may cause disability or pain) as well as broader impacts of the disease on functioning in wok and social roles. For instance, an individual may perceive that HIV is not medically serious, but if he or she perceives that there would be serious financial consequences because of being absent from work for several days, then he or she may perceive HIV to be a particularly serious condition.

**Perceived susceptibility:** Perceived susceptibility refers to subjective assessment of risk of developing a health problem. The health belief model predicts that individuals who perceive that they are susceptible to a particular health problem will engage in behaviours to reduce their risk of developing the health problem. Individuals with low perceived susceptibility may deny that they at risk for contracting a particular illness. others may acknowledge the possibility that they could develop the illness, but believe it is unlikely. Individuals who believe they are at low risk of developing an illness are more likely to engage in unhealthy, or risky, behaviours. Individuals who perceive a high risk that they will be personally affected by a particular health problem are more likely to engage in behaviours to decrease their risk of developing the condition. The combination of perceived severity and perceived susceptibility is referred to as perceived threat. Perceived severity and perceived susceptibility to a given health condition depend on knowledge about the condition. The health belief model predicts that higher perceived threat leads to higher likelihood of engagement in health-promoting behaviour.

**Perceived benefits:** Health-related behaviours are also influenced by the perceived benefits of acting. Perceived benefits refer to an individual’s assessment of the value or efficacy of engaging in a health-promoting behaviour to decrease risk or disease. If an individual believes that a particular action will reduce susceptibility to a health problem or decrease its seriousness, then he or she is likely to engage in that behaviour regardless of objective facts regarding the effectiveness of the action. For example, individuals who believe that wearing sunscreen prevents skin cancer are more likely to wear sunscreen than individuals who believe that wearing sunscreen will not prevent the occurrence of skin cancer.

**Perceived barriers:** Health-related behaviours are also a function of perceived barriers to acting. Perceived barriers refer to an individual’s assessment of the obstacles to behaviour change. Even if an individual perceives a health condition as threatening and believes that a particular action will effectively reduce the threat, barriers may prevent engagement in the health promoting behaviour. In other words, the perceived benefits must outweigh the perceived barriers for behaviour change to occur. Perceived barriers to acting include the perceived inconvenience, expense, danger (e.g., side effects of a medical procedure) and discomfort (e.g., pain, emotional upset) involved in engaging in the behaviour. For instance, lack of access to affordable health care and the perception that a flu vaccine shot will cause significant pain may act as barriers to receiving the flu vaccine.

**Modifying variables:** Individual characteristics, including demographic, psychological and structural variables, can affect perceptions (i.e., perceived seriousness, susceptibility, benefits, and barriers) of health-related behaviours. Demographic variables include age, sex, race, ethnicity, and education, among others. Psychosocial variables include personality, social class, and peer and reference group pressure, among others. Structural variables include knowledge about a given disease and prior contact with the disease, among other factors. the health belief model suggests that modifying variables affect health-related behaviours indirectly by affecting perceived seriousness, susceptibility, benefits, and barriers.

**Cues to action:** The health belief model posits that a clue, or trigger, is necessary for promoting engagement in health – promoting behaviour. Cues to action can be internal or external, physiological cues (e.g., pain, symptoms) are an example of internal cues to action. External cues include events or information from close others, the media, or health care providers promoting engagement in health-related behaviours. Examples of cues to action include a reminder postcard from a dentist, the illness of a friend or family member, and product health warning labels. The intensity of cues needed to prompt action varies between individuals by perceived susceptibility seriousness, benefits, and barriers. For example, individuals who believe they are at high risk for a serious illness and who have an established relationship with a primary care doctor may be easily persuaded to get screened for the illness after seeing a public service announcement, whereas illness and do not have reliable access to health care may require more intense external cues to get screened.

**Self-efficacy:** This was added to the four components of the health belief model (i.e., perceived susceptibility, seriousness, benefits, and barriers) in 1988. Self-efficacy refers to an individual’s perception of his or her competence to successfully perform a behaviour. Self-efficacy was added to the health belief model to better explain individual differences in health behaviours. The model was originally developed to explain engagement in one-time health-related behaviours such as being screened for cancer or receiving an immunization. Eventually, the health belief model was applied to more substantial, long-term behaviour change such as diet modification, exercise, and smoking. Developers of the model recognized that confidence in one’s ability to effect change in outcomes (i.e., self-efficacy) was a key component of health behaviour change.

**Limitation of the HBM**

The health belief model attempts to predict health-related behaviours by accounting for individual differences in beliefs and attitudes. However, it does not account for other factors that influence health behaviours. For instance, habitual health-related behaviours (e.g., smoking, seatbelt buckling) may become relatively independent of conscious health-related decision-making process. Additionally, individuals engage in some health-related behaviours for reasons unrelated to health (e.g., exercising for aesthetic reasons). Environmental factors outside an individual’s control may prevent engagement in desired behaviours. For example, an individual living in a dangerous neighbourhood may be unable to go for a jog outdoors due to safety concerns. Furthermore, the health belief model does not consider the impact of emotions on health-related behaviour. Evidence suggests that fear may be key factor in predicting health-related behaviour.

The theoretical constructs that constitute the health belief model are broadly defined. So, the health belief model does not specify how constructs of the model interact with one another. Therefore, different operationalizations of the theoretical constructs may not be strictly comparable across studies.

**Application of theory to the present study**

The independent variable for the study was derived from one of the constructs of the HBM namely self-efficacy. Self-efficacy (the ability to effectively calculate medication doses) was identified as the independent variable. It is presumed that self-efficacy will promote knowledge about drug calculation. More so, where the self-efficacy is poor, then poor knowledge of medication error is promoted. In addition, it is conceived that the extent of knowledge of drug calculation will ultimately result in a certain level of risk for medication error.

The intervening variable refers to factors that could moderate the influence of the independent variable on the dependent variable. For the present study, the intervening variable was adapted from one of the constructs of the HBM namely modifying factors especially socio-demographic factors, cues to action (like continuing education), and psychological factors (reference group influence).

The dependent variable for the study is Drug calculation skills. It is presumed that poor self-efficacy results in poor drug calculation skill. This theorized link between self-efficacy (Health Belief Model) and drug calculation skill informed the conceptual model for this study illustrated in Figure 1 below.

**Dependent variable**

**Intervening variable**

**Independent variable**

**Self-efficacy**

**Need to protect oneself from litigation.**

**Health Belief model**

**Socio-demographic**

Age

Educational level

Occupation

Previous experience

Job experience

**Psychological**

Peer pressure

Reference groups

Personality

**Drug calculation skills of the nurse**

**Figure 1:** Conceptual model for the study (an adaptation of the HBM)

**Empirical Review**

Wenneberg-Capellades et al. (2022) conducted a study on where do nurses make mistakes when calculating drug dosages? A retrospective study. The aim of the study was to analyse where specifically nursing students make mistakes when calculating drug doses. Retrospective analysis of written examination papers including dosage calculation exercises from years 1, 2, and 3 of a nursing degree program. Exercises were analysed for errors in relation to 23 agreed categories reflecting different kinds of calculation or steps in the calculation process. A descriptive and bivariate analysis of results was conducted, examining the relationship between the presence of errors and the proportion of correct and incorrect final answers. The study revealed that a total of 285 exam papers including 1034 calculation exercises were reviewed. After excluding those that had been left blank, a total of 863 exercises were analysed in detail. A correct answer was given in 455 exercises (52.7%), although this varied enormously depending on the type of exercise: 89.2% of basic dose calculations were correct, compared with just 2.9% of those involving consideration of maximum concentration. The most common errors were related to unit conversion, more complex concepts such as maximum concentration and minimum dilution, or failure to contextualize the answer to the clinical case. Other frequent errors involved not extracting the key information from the question, not including the units when giving their answer, and not understanding the question. In general, fewer errors in basic dose calculations were made by students at later stages of the degree program. It was concluded that, students struggle with more complex dose calculations. The main errors detected were related to understanding the task and the key concepts involved, as well as not following the correct steps when solving the problem.

**Ardahan-Akugal et al. (2019) conducted a study on determination of senior nursing students’ mathematical perception skills and paediatric medication calculation performance.** The study aimed to determine the senior nursing students' mathematical perception skills and paediatric medication calculation performance.  **The descriptive cross-sectional research was** composed of 103 nursing students attending a state university in Izmir, Turkey. Of the 103 nursing students, 97 who answered all the questions comprised the study sample. All the participants took one-month training in the paediatric clinics during the last year of their education. The data were collected using the "Personal Information Form and Mathematics Perception, Information and Paediatric Drug Calculator Skills Survey" developed by the researchers by reviewing the literature. The mean age of the study participants was 22.24±0.89. Of them, 76.3% were female, 23.7% completed their Paediatric Internship Training in the paediatric inpatient units or the Paediatric Intensive Care Unit (PICU), 68% thought that their basic mathematics knowledge was adequate, and %30 stated that their dosage calculation, solution preparation and drug preparation skills were insufficient. In addition, the rate of the correct answers they gave to the questions on percentages, fractions and conversions was low. The study concluded that;In the drug application process; not only practical skills, but also the theoretical knowledge should be considered. A nurse's responsibility does not end once he/she administers medication. Being careful throughout the entire process is one of the nurse's legal and ethical responsibilities. In this study, the students' drug calculation skills were inadequate.

Malcom and Eastwood (2018) completed a study on Infusion drip drop rate calculation among nurses in Australia. A cross-sectional design was used on 200 randomly selected nurses. A paper –based calculation questionnaire was used for data collection. Data was analyzed at p < 5% using descriptive and inferential statistics. Findings revealed that 41.6% demonstrated poor knowledge of medication calculations. The poor conceptual knowledge stood at 20%. Arithmetic and formula errors were 60% and 20% respectively. The authors concluded that there is good theoretical knowledge but poor practical application of knowledge relating to infusion dose calculation among nurses.

Westbrook and Parry (2018) carried out a study on Errors in administration of intravenous medications in Australia.A prospective design was used on 107 randomly selected nurses on six wards across two teaching hospitals. An observation sheet was used for data collection. Data analysis was done with descriptive and inferential statistics at 5% level of significance. In all, 67% of the nurses had at least one error with calculation and setting of the gravity infusion set, hence wrong infusion rate. Infusion rate error decreased with increasing experience by about 10.9% (RR 0.89, p = <0.001). The authors concluded that infusion error was widespread among nurses.

Lyons et al. (2017) did a study on Errors and discrepancies in the administration of intravenous infusions. A prospective mixed-method design was used on 2008 randomly selected nurses from 11 hospitals. Direct observation approach was used for data collection. Data analysis was done with descriptive and inferential statistics at 5% level of significance. Discrepancies between prescribed flow rate and infused rate were observed in 53% of infusions. Special training on fluid infusion therapy reduced medication errors by 35% (p = <0.001) but not educational qualification (p = 0.412). The authors concluded that medication errors were relatively common.

Fekadu et al. (2017) conducted a study on prevalence of intravenous medication administration errors in Ethiopia. A cross-sectional design was used on 134 randomly selected nurses. A checklist was used for data collection. Data analysis was done with descriptive and inferential statistics. P < 0.05 was considered statistically significant. Results showed that infusion rate errors were seen in 46.1%. Age and educational qualification was not associated with infusion error (p = 0.023). The authors concluded that there is high prevalence of infusion error.

Rooker and David (2017) completed a study on Errors in fluid infusion rates in Wycombe. The study utilized a prospective design during a 4-week period on 207 randomly selected nurses. An observation sheet was used for data collection. Data analysis was done with descriptive and inferential statistics at p<5%. Results showed that only 26% of the infusions were correctly administered. About 67% were infused too slowly, and 8% were infused too fast. About 79% of the nurses showed adequate theoretical knowledge of medication error. The authors concluded that amidst good knowledge of medication error, nurses still made errors with infusion flow rate.

Bagheri-nesami et al. (2015) did a study on intravenous medication administeration errors in Iran. A descriptive design was used for the study. A sample size of 240 randomly delected nurses were examined. An infusion calculation quiz was used for data collection. Data analysis was done with descriptive and chi square statistics. About 51.5% errors were observed. Knowledge base was good at 76%.

Green (2015) conducted a study on Predictors of infusion fluid administration error in an Australian tertiary hospital. A prospective design was used for the study on 687 consecutively selected nurses. Direct observation sheet was used for data collection. Data analysis was done with descriptive statistics. About 18% had an error with intravenous rate. The authors concluded that more significant error with infusions is evident.

**Summary of Literature Review**

Related literature was reviewed in line with the objectives of the study under the following sub-headings: Drop factor, types of macro drip set and their drop factors, measurement of drop factor of macro drip set, and infusion delivery dose calculation techniques. The theory underpinning the study is the *Health Belief Model (1988 version)*. A conceptual model was developed for the study. Self-efficacy (the ability to effectively calculate medication doses) was identified as the independent variable. Socio-demographic factors, cues to action (like continuing education), and psychological factors (reference group influence) were identified as the intervening variables. Drug calculation skill was identified as the dependent variable. Nine empirical studies were reviewed. Majority of the studies found inadequate infusion calculation skills among nurses. Moreover, no published study examined nurses in Nigeria, especially Abia State. This presents a gap in existing knowledge which this current study hopes to fill.

**CHAPTER THREE**

**METHODOLOGY**

This chapter discussed the research design for the study, area of study, target population, sample size, sampling procedure, instrument for data collection, validity and reliability of instrument, ethical consideration, procedure for data collection and method of data analysis.

**Design**

A descriptive cross-sectional design was adopted for this study. It is a type of observational study involving surveying a population at a given point in time and requires no manipulation and requires no manipulation of variables by the researcher (Polit & Beck, 2012). It is used to describe characteristics of a population or to examine associations between variables. Stake-Nilsson et al (2022) utilized this design successfully in a related study on medication calculation.

**Setting**

For the purpose of this Federal Medical Centre, Umuahia in Abia State within the south-eastern part of Nigeria. It is a tertiary healthcare institution established in 1945, it was formerly known as Queen Elizabeth Specialist Hospital, Umuahia and was renamed in November 1991 to Federal Medical Centre, Umuahia. The hospital covers an area of 77 acres of land bounded on the south by the Nigerian prisons, Umuahia; east by Ndume Ibeku; North by Umuahia Urban and west by Afara clan. The Centre offers round the clock services, providing specialized medical care for both inpatients and outpatients. The centre is managed by the Federal Ministry of Health and provides tertiary healthcare services. The Federal Medical Centre, Umuahia has a total of 327 beds, with a total of 1,600 staff members, 305 of which are nurses. The centre has a wide range of services and facilities, which include an inpatient unit, an outpatient department, an intensive care unit, a labour and delivery unit, a radiology department, a pharmacy, a laboratory, a dialysis centre, a blood bank, and an operating theatre. The Federal Medical Centre, Umuahia also offers a variety of diagnostic services, such as X-rays, ultrasounds and CT scans, as well as a wide range of specialty services, including internal medicine, cardiology, endocrinology, gastroenterology, nephrology, neurology, and urology. The Centre also provides a range of health education and prevention services, such as nutritional counselling, health promotion and disease prevention programmes and health education services. The Federal Medical Centre, Umuahia is committed to providing quality healthcare services and has a strong focus on patient safety and satisfaction. The Centre has established a Quality Assurance and Improvement Unit, which is responsible for monitoring and evaluating the quality of services provided by the centre. The centre also has a Patient Safety and Risk Management Unit, which is responsible for the prevention of medical errors and adverse events. This makes Federal Medical Centre, Umuahia a good and viable place to carry out this study.

**Target Population**

The population for the study is registered and licensed nurse-midwives (including the nurse interns who have completed their licensure examinations). At the time of this study, there were at least 305 licensed and practicing nurses (nurse interns inclusive) working in all wards of Federal Medical Centre, Umuahia.

**Sample Size**

A sample size of 187 was calculated for this study. The Cochran’s (1977) formula cited in Bolarinwa (2020) for calculating sample size when population is infinite was used to determine the sample size for the study. Applying $n= \frac{Z^{2pq}}{e^{2}}$ (Cochran, 1977) where Z is the critical value for desired confidence level (1.96), p is the estimated of proportion of attribute in population (50%), e is the margin of error (5%); a minimum required sample size of 384 was calculated. Based on the premise that the population is less than 10,000, a finite sample size correction formula was applied mathematically expressed as n\* = n ₊ (1 + n/No); where n\* is the final sample size, No is the total population (305). A final sample size of 170 was computed. Taking into consideration the non-response factor, the calculated sample size was increased by an extra 10% to give a sample size of 187. Furthermore, 25 macro drip/adult-drip sets of (5 each from different brand names) were slated to be selected for inspection.

**Sampling Technique**

Simple random sampling was strictly applied. Firstly, simple random sampling (blind lucky dip) was used to select and enrol nurses (respondents) from the hospital.

The criteria for inclusion or enrolment of respondents into the study were:

1. Willingness to participate in the study,
2. Currently working in FMC Umuahia,
3. Can read and write in English language,
4. Can use a calculator,
5. Physically and mentally stable enough to respond to questionnaire items.

In addition, purposive sampling was used for the selection of the 25-macro drip/adult-drip sets from the pharmacy department of Federal Medical Centre, Umuahia for inspection of the labelled drop factor which was found to be **20 drops per ml** for all the selected specimen.

**Instruments for data Collection**

The Instrument for data collection was a semi-structured questionnaire designed by the researcher which had two sections. Section A was designed to extract demographic data (items 1-7) while Section B was a mathematical problem to assess drug calculation skills (Appendix B). A cover letter was attached to the instrument.

**Validity of Instrument**

For face validity, the instrument was submitted to three nursing research experts in the Department of Nursing Sciences, Abia State University, Uturu. They cross checked the font size, character, organization and sequence or arrangement of items on the questionnaire. They identified areas of temporal ambiguity and offered suggestions for correction. They verified that items on the questionnaire corresponded with the operational variables of interest. Their corrections and suggestions were affected to better adapt the instrument to meet relevant objectives of the study.

For content validity of the instrument, all three research experts were requested to mark relevant (1 mark) or not relevant (0 mark) for each of the questionnaire items. On analysis of the generated data, the Content Validity Index of the questionnaire was calculated to be **0.833** (Appendix C). A Content Validity Index of scale > 0.75 depicts good content validity as advocated by Polit and Beck (2012).

**Reliability of Instrument**

To test the reliability of the instrument, a pre-testing of the instrument was carried out using 20 nurses practicing in Abia State Teaching Hospital. It was chosen because it is a government hospital and is also situated in Abia State in the south-eastern of Nigeria. In testing the reliability of the instrument, a split half method was used to estimate consistency of the instrument. The filled questionnaires were numbered and separated into even and odd number groups. A split half correlation was computed for the two groups of responses to estimate the reliability index. A reliability index of **0.65** was calculated (Appendix D). A split half reliability index > 0.50 depicts good reliability of the instrument as recommended by Polit and Beck (2012).

**Method of Data Collection**

Data collection from respondents was done daily, between the hours of 4:00 – 6:00 pm. This was done in order not to interrupt or disturb important daily clinical activities. The researcher briefed the respondents on the purpose of the study. On designated days and times, respondents who meet the pre-stated inclusion criteria were given the instrument to fill in their responses. A total of 187 copies of section A of the instrument were administered to selected respondents. The administered questionnaire was retrieved after fifteen minutes from administration. This was done to checkmate time-maturation threat on the validity of the study (third party interference with responses).

**Method of Data Analysis**

The instrument generated a mix of categorical, ordinal, interval and ratio data. Based on this, generated data was subjected to descriptive statistics (mean, standard deviation, frequency, and percentages). Inferential statistics (Chi square and Fisher exact test) was used for test of hypotheses. Level of significance will be set at *P* < 0.05. Results were presented in tables.

**Ethical Consideration**

This topic was cleared by the research committee of Department of Nursing Sciences, Abia State University, Uturu. Administrative permission was obtained from authorities managing Federal Medical Centre, Umuahia before accessing the respondents. Informed oral consent was obtained from each of the respondents before data collection and respondent anonymity was maintained throughout the duration of the study.

**CHAPTER FOUR**

**RESULTS**

Out of the 187 administered instruments, 186 were returned to the researcher and was analyzed (Response rate 99.3%).

**Socio-demographic characteristics of respondents**

**Table 1**: Summarized the socio-demographic profile of respondents **n = 186**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Category** | **Mean (SD)** | **f** | **%** |
|  |  |  |  |  |
| Age (in years) | 20-29 |  | 63 | 33.9 |
| 30-39 |  | 61 | 32.8 |
| 40-49 |  | 52 | 28.0 |
| 50-59 |  | 10 | 5.3 |
| Mean | 35.5(6.9) |  |  |
|  |  |  |  |  |
| Gender/Sex | Female |  | 169 | 90.9 |
| Male |  | 17 | 9.1 |
|  |  |  |  |  |
| Job description | Nurse |  | 15 | 8.1 |
|  | Nurse intern |  | 171 | 91.9 |
|  |  |  |  |  |
| Highest Educational Qualification | Diploma |  | 54 | 29.0 |
| BN.Sc |  | 97 | 52.2 |
| PGD |  | 28 | 15.1 |
| M.Sc |  | 7 | 3.7 |
|  |  |  |  |  |
| Attended any special training on intravenous fluid administration | No |  | 153 | 82.3 |
| Yes |  | 33 | 17.7 |

Table 1 summarized the background socio-demographic characteristicsof the respondents, and it showed that the age of respondents ranged from 20 to 59 years (mean 35.5 (6.9) years). Majority (63; 33.9%) of the respondents were aged between 20 and 29 years old. Most of the study participants were females (169; 90.9%) and were nurse interns (171; 91.9%). About half of them had Bachelor of Nursing Science (BNSc) degree as their highest educational qualification (97; 52.2%). Majority of the study participants had not attended any special training on intravenous administration (153; 82.3%).

**Research Question 1:** What is the nurse’s ability to state the correct formula used in drug calculation?

Figure 2 below summarized the nurses’ ability to state the correct formula for drug calculation.

**Figure 2:** Nurses’ ability to state the correct formula for drug calculation.

Figure 2 summarized responses to item 7 and showed that majority of the respondents (81.1%) could adequately state the correct formula for drug calculation.

**Research Question 2:** What is the ability of the nurses to state the correct macro drip set drop factor used in Federal Medical Centre, Umuahia?

Figure 3 below summarized the ability to state the correct macro drip set drop factor.

**Figure 3:** Nurses’ ability to state the correct macro drip set drop factor.

Figure 3 summarized the ability of the nurses to state the correct macro drip set drop factor used in Federal Medical Centre, Umuahia. It revealed that about half (97; 52.2%) of the respondents were able to state the correct macro drip set drop factor (20 drops per ml). Nonetheless, about 47.8% of the respondents were not able to state the correct macro drip set drop factor as they stated 15 drops per ml instead of 20 drops per ml.

**Research Question 3**: What is the ability of the nurses to arrive at the correct drip flow rate?

Figure 4 summarized the ability of the nurses to arrive at the correct drip flow rate.

**o**

**Figure 4**: Nurses’ ability of the nurses to arrive at the correct drip flow rate.

Figure 4 summarized the ability of the nurses to arrive at the correct drip flow rate. It showed that a total of only 15 (8.10%) respondents had the competence to arrive at the correct drip flow rate. Majority of the respondents (171; 91.9%) were unable to arrive at the correct drip flow rate.

**Research Question 4:** What is the association between drug calculation skill and nurses’ educational qualification?

Research question 4 will be answered by testing the following null hypotheses.

**Hypotheses 1**: There is no significant association between the nurses’ educational qualification and drug calculation skills.

Table 2 tested hypothesis 1 using Chi square inferential statistical tool at 0.05 significance level.

**Table 2**: Chi square test of association between Drug calculation skills and educational qualification of nurses

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | **Educational Qualification** | **df** | **χ2** | **P value** |
|  |  | Diploma | BNSC | PGD | MSc |  |  |  |
| **Drug** **calculation** **skills** |  |  |  |  |  | 15 | 13.92 | 0.532 |
| Ability to state formula. | Correct | 43 | 82 | 21 | 5 |  |  |  |
| Wrong | 11 | 15 | 7 | 2 |  |  |  |
| Ability to state the correct macro drip set factor. | correct | 23 | 55 | 16 | 3 |  |  |  |
| Wrong | 31 | 42 | 12 | 4 |  |  |  |
| Ability to arrive at the correct drip flow rate. | Correct | 3 | 5 | 6 | 1 |  |  |  |
| wrong | 51 | 92 | 22 | 6 |  |  |  |

**Decision rule**: p < 0.05 is significant; > 0.05 is not significant.

Table 2 revealed that there was no significant association between the educational qualification of nurses and drug calculation skills (χ2 **=** 13.92, df = 15, p = 0.532). The poor drug calculation skills of the respondents were not because of their educational qualification.

**CHAPTER FIVE**

**DISCUSSION OF FINDINGS**

This chapter discussed the major findings of this study.

**Research Question 1:** What is the nurse’s ability to state the correct formula used in drug calculation?

This study found that most of the respondents had adequate ability (81.1%) in stating the correct formula for drug calculation. This finding corroborates Malcom and Eastwood (2018) who in a study on Infusion drip drop rate calculation among nurses in Australia found that 58.4% of nurses demonstrated good theoritical knowledge of drug calculation. The similarity in findings could be linked to the design used for the study. Both this study and Malcom and Eastwood (2018) utilized cross-sectional design which allows researchers to observe phenomenon without manipulation of factors and variables. This finding was also in line with Bagheri-nesami et al (2015) who in a study on intravenous medication administeration errors in Iran found that nurses’ knowledge of medication calculation formulae was good at 76%. The proximity in findings could be connected to the similarities in research design utilized for the study. It was also in agreement with Rooker and David (2017) who in a study on Errors in fluid infusion rates in Wycombe reported that 79% of the nurses showed adequate theoretical knowledge of drug calculation.

**Research Question 2:** What is the ability of the nurses to state the correct macro drip set drop factor used in Federal Medical Centre, Umuahia?

This study found that about half (52.2%) of the respondents demonstrated adequate ability in stating the correct drip set factor for drug calculation. About 47.8% of the respondents were not able to state the correct macro drip set factor. This finding agreed with the study of Malcom and Eastwood (2018) on Infusion drip drop rate calculation among nurses in Australia which found that about 41.6% had poor infusion calculation abilities. The similarities in results could be linked to the research design utilized which was cross-sectional in nature. This finding was also in line with Wenneberg-Capellades et al. (2022) where 52.7% respondents were able to state the correct macro drip set drop factor. The similarity in findings could be linked to the probability-based sampling technique utilized in this study. Probability sampling technique reduces the chance of systematic bias.

**Research Question 3**: What is the ability of the nurses to arrive at the correct drip flow rate?

This study found that only very few (8.10%) of the respondents had the both the theoretical and arithmetic ability to arrive at the correct drip flow rate. In addition, about 91.9% of the respondents did not have the ability and skill to arrive at the correct drip flow rate. This finding was completely supported by Ardahan-Akugal et al. (2019) study on determination of senior nursing students’ perception skills and paediatric medication calculation performance which revealed that the drug calculation skills of the student were inadequate. The authors also wrote that in the drug calculation process; not only theoretical knowledge, but also the arithmetic skill should be considered. A nurses responsibility doe does not end in correctly stating the drug calculation formula or correctly stating the macro drip set factor but also involves being careful throughout the entire process. Drug calculation is one of the nurse’s legal ethical responsibilities. Furthermore, this finding supported Wenneberg-Capellades et al. (2022) who in a study on where nurses make mistakes when calculating drug dosages, reported that the skill of nurses on drug calculation varied enormously depending on the type of exercise of basic dose calculations and that drug calculation skills involves maximum concentration. The study also reported that common inadequacies were related to unit conversion and more complex concepts such as maximum concentration and minimum dilution, or failure to contextualize the answer.

**Research Question 4:** What is the association between drug calculation skill and nurses’ educational qualification?

Research question 4 was answered by testing the following null hypotheses:

***Hypothesis 1*:** There is no significant association between educational qualification and drug calculation skills.

This study found that there was no significant association between the drug calculation skills and educational qualification among nurses (*P = 0.532*). This eventually relates to a lack of practice skill in drug calculation. This finding support Lyons et al. (2017) who in a study on errors and discrepancies in the administration of intravenous infusions found that discrepancies between prescribed flow rate and infused rate were observed in 53% of infusions *(p = < 0.001*) irrespective of the educational qualification of the attending nurse. The similarity in findings was expected based on the idea that studies examined clinical nurses. Furthermore, this finding corroborates Rooker and David (2017) who in a study on errors in fluid infusion rates in Wycombe reported that about 67% were infused too slowly, and 8% were infused too fast in discrepancy from the actual prescribed dose. Such discrepancies are pivoted on the macro drip set drop factor used in infusion calculations.

**Summary**

This study examined the drug calculation skills and associated factors among nurses in Federal Medical Centre, Umuahia in south-eastern Nigeria. This cross-sectional study was conducted in January-April 2023. To evaluate the drug calculation skills and associated factors among nurses. A sample of 187 nurses was selected using simple random sampling technique. Data were collected using the Adult Infusion Dose Calculation Quiz (AIDCQ) for Nurses designed by the researcher. Collected data were summarized and analysed at 5% level of significance. Results demonstrated that the respondents who had adequate ability in stating the correct formula for drug calculation was 81.1%. About 52.2% were able to state the correct macro drip set of 20 drops per ml while 47.8 % stated a wrong macro drip set factor of 15 drops per ml. About 91.9% could not arrive at the correct drip flow rate. There was no significant association between educational qualification of nurses and their drug calculation skills (χ2 **=** 13.92, df = 15, p = 0.532).

**Conclusion**

The respondent nurses have good theoretical knowledge of drug calculation formula but were highly prone to errors in drug calculations involving macro drip sets. Their drug calculation skills were not determined by their educational qualification.

**Implications of Findings for Nursing Practice**

This study observed that nurses had poor drug calculation skills and palpable risk of drug calculation error. The implications of this study thus include the following:

1. Nurse-administrators should engage in sensitization and awareness creation on importance of continuing education trainings for nurses in infusion therapy and management.
2. Nurse-educators should liaise with appropriate experts to review textbooks used in nursing colleges in line with existing clinical equipment realities.

**Recommendations**

Based on the findings of this study, the following recommendations were made:

1. The researcher recommended that nurses should receive adequate training and support to improve their drug calculation skills.
2. More training on infusion therapy and drug calculation should be organized by nurses for update of practice.
3. Nurses should be given access to structured training and educational materials. This should include both online and in-person workshops, which focus on the principles of drug calculation, such as drug measurements, conversions, and calculations.
4. Additionally, nurses should be provided with frequent opportunities to practice their skills through quizzes, simulations, and case studies.

**Limitation of the study**

The researcher considers the following as limitations to this study:

***Time maturation threat to validity***: as the study participants were allowed to fill the instrument at their chosen space. This may have exposed the respondents to some interaction with other collegues while filling the instrument, hence may have contaminated the responses. Based on the identified limitations, the findings of this study must be interpreted with caution regarding generalization outside this study population.

***Design***: the design of this study involved one facility as opposed to a multi-facility study. It may be possible that a different result could be obtained if the study were expanded to more than one facility. Based on the fore-mentioned, the results of this study may not be ideal for generalization purposes outside this study sample

**Suggestions for Further Studies**

Further studies on the following topic are suggested:

1. Environmental predictors of drug calculation skills among nurses.
2. Occupational predictors of drug calculation skills among nurses
3. Drug calculation skills of nurses: A multi-facility study.

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**Appendix A**

**COVER LETTER**

Department of Nursing Science

Abia State University Uturu

13 April 2023

Dear Respondent,

I am a student in the above-named institution. I am carrying out a research study on Drug Calculation Skills and Associated Factors Among Nurses. This study may enable educators and clinicians to better meet the needs of individuals, patients and student groups. Would you please assist us in this study by completing the enclosed questionnaire? Your opinion and experiences are very important to us and are needed to give an accurate picture of the said study.

The questionnaire is completely anonymous, so you are not asked to put your name on it. I hope, therefore, that you will feel comfortable giving your honest opinions.

Your participation in this study is completely voluntary. By returning the study questionnaire filled with your responses, you will be completing the cycle of granting us your consent to participate in the study.

Thank you in advance.

**Nicole Chizoba Onyenobi** (researcher)

**APPENDIX B**

**QUESTIONNAIRE**

**TOPIC:** Drug Calculation Skills and Associated factors Among Nurses.

**Instruction**: Please write or tick your honest response to the questionnaire items.

**Section A: Socio-demographic Profile**

1. How old were you on your last birthday? …………. (Please write)
2. What is your gender?
	1. Female [ ]
	2. Male [ ]
3. What is your highest educational qualification in Nursing Sciences?
	1. Diploma [ ]
	2. Bachelors [ ]
	3. Post graduate diploma [ ]
	4. Masters [ ]
	5. Ph.D [ ]
4. Which is your job description?
	1. Nurse-midwife [ ]
	2. Nurse intern [ ]
5. Have you attended any continuing education programme on drug calculation?
	1. No [ ]
	2. Yes [ ]
6. Have you attended any continuing education programme on intravenous fluid administration?
	1. No [ ]
	2. Yes [ ]
7. Do you know the correct formulae used in drug calculation?
	1. No [ ]
	2. Yes [ ]

**Section B**:

1. Using a calculator solve the following. A prescription order reads Rx: infuse 100mls of metronidazole over 50minutes using the adult macrodrip mostly used in the ward. At what drop rate (in drops per minute) will you set the infusion? (Show clearly all working).

**Show all working for your calculation of number 8 here:**

**Appendix C**

**Content Validity of Instrument**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Item number** | **Item** | **Response of** **Expert 1** | **Response** **of** **Expert 2** | **Response** **of** **Expert 3** | **Item** **validity** |
|  | Socio-demographic data |  |  |  |  |
| **1** | How old were you on your last birthday? …………. | 1 | 1 | 1 | **1** |
| **2** | What is your gender? | 1 | 1 | 1 | **1** |
| **3** | What is your highest educational qualification in Nursing Sciences? | 1 | 1 | 1 | **1** |
| **4** | Which is your job description?  | 1 | 0 | 0 | **0.333** |
| **5** | Have you attended any continuing education programme on drug calculation? | 0 | 1 | 1 | **0.666** |
| **6** | Have you attended any continuing education programme on intravenous fluid administration? | 1 | 1 | 0 | **0.666** |
| **7** | Do you know the correct formula used in drug calculation? | 1 | 1 | 1 | **1** |
| **8** | Using a calculator solve the following. A prescription order reads Rx: infuse 100mls of metronidazole over 50minutes using the adult macrodrip mostly used in the ward. At what drop rate (in drops per minute) will you set the infusion? | 1 | 1 | 1 | **1** |
|  |  |  |  |  |  |
|  | **Content Validity Index of Scale (CVI)** |  |  |  | **0.833** |

**Decision rule:** CVI > 0.8 = Valid instrument

**Appendix D**

**Reliability Test of Instrument**

|  |  |  |  |
| --- | --- | --- | --- |
| **Pilot respondent** | **Group 1** | **Group 2** | **r** |
| **1** | 3 | 2 | **0.65** |
| **2** | 3 | 3 |  |
| **3** | 0 | 1 |  |
| **4** | 2 | 3 |  |
| **5** | 1 | 2 |  |
| **6** | 2 | 1 |  |
| **7** | 2 | 2 |  |
| **8** | 3 | 3 |  |
| **9** | 3 | 2 |  |
| **10** | 1 | 1 |  |

**Decision rule:** r > 0.50 = reliable instrument.

**Reliability index “r” was calculated using SPSS 21.**