SHENDI UNIVERSITY

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Nurses' Knowledge Regarding Invasive hemodynamic monitoring In Cardiac Intensive Care Unit at Sudan Heart Center, Khartoum, Sudan (2017)

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B.Sc. in Nursing

Khartoum University (2006)

A Dissertation

Submitted to University of Shendi in Partial Fulfillment of the Requirement for the Award of the Degree of Master of Sciences

In

Critical & Emergency Care Nursing

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PhD in Medical Surgical Nursing

Sudan April 2017

قال تعالى:

{قُلْ هَلْ يَسْتَوِي الَّذِينَ يَعْلَمُونَ وَالَّذِينَ لاَ يَعْلَمُونَ إِنَّمَا يَتَذَكَّرُ أُولُو الأَلْبَابِ}

(صدق الله العظيم)

الآية (9) سورة الزمر

Dedication

I dedicate this work to ………..

My mother and father with love and respect

&

my family, my brothers & sister

&

My best friends

To everyone who support and stand beside me during my study

Acknowledgement

Greatest thanks firstly to our God for his grace which enablemeto complete this study. My thanks owed to faculty of post graduate and Scientific research University of Shendi. I would like express my deepest and sincere gratitude to my supervisor Dr.Sania Ahmed Mohamed and my colleague Dr. AltayebAbduazeemIdress for their helpful advices and valuable suggestion to me at the various stages of the research and their useful Supervision. My thanks to all members of study sample and to my colleagues.

Abstract

Invasive hemodynamic monitoring is the use of monitoring devices to measure cardiovascular function, monitoring positively affect patient care and the practitioner must be able to interpret the data in the clinical setting, separate data from artifact, and conceptualize the physiologic, biochemical, or pharmacologic basis for the changes observed. This study aimed to assess critical care nurses knowledge in invasive hemodynamic monitoring in Sudan heart center 2017.

A descriptive study was conducted. It includedcritical care nurses how worked in intensive care unit in Sudan heart center.Data were collected from 30 critical care nurses worked in ICU using validated questionnaire .the data were analyzed by statistical package of social services version (20). The result showed that more than half of study sample are worked less than 5 years,majorty of them have bachelor dgree and most of them didn’t recive course about invasive hemodynamic monitoring. And less than half of nurses have good knowledge about devices used for invasive hemodynamic monitering, one third of study sample have good knowledge about indications of IHDM, indication of PAPM,and indication about arterial pressure monitoring.

According to result of this study the knowledge of critical care nursing in invasive hemodynamic monitoring was unacceptable. The effect of demographic data on nurse's knowledge was significant and Lack of trained staff are beerier facing staff performance 50% of critical care nurses said that. The study recommended that, designing logbook about invasive hemodynamic monitoring and to be available for nurses in hospital. Periodic training program and courses about invasive hemodynamic monitoring with continuous supervision to assess the impact in performance.

مستخلص البحث

مراقبة الدورة الدموية الغازية عبارة عن استخدام اجهزة الرصد لقياس وظيفة القلب والاوعية الدموية مما يؤثر إيجابيا على رعاية المرضى و على ممارسي المهنة القدرة على تفسير ومعالجة البيانات سريريا وتمييز البيانات الخاطئه من الصحيحه لتحديد التغيرات الفسيلوجيه والحيويه الملاحظه . أجريت هذه الدراسة الوصفية بمركز السودان للقلب الخرطوم السودان. وهدفت إليتقييم معلومات الممرضين والممرضات تجاه اجهزة مراقبة الدورة الدموية الغازية لمرضى القلب بالعناية الحثيثه لمركز السودان للقلب. اشتملت عينة الدراسة علي30 ممرض وممرضة أثناء الفترة من(مارس –سبتمبر2017م). تم جمع البيانات باستخدام استمارة استبيان تم تصميمها لغرض الدراسة. تم تحليل البيانات باستخدام برنامج الحزمة الإحصائية للعلوم الاجتماعية(SPSS). قد تم استعمال طريقة ليكرت لقياس المعرفة. أسفرت نتائج البحث عن أن اكثر من نصف عينة الدراسة من حملة البكالريوس ولم يتلقوا كورس عن اجهزة مراقبة الدورة الدموية الغازية لمرضى القلب، واقل من نصف عينة الدراسة كانت لديهم المعرفة الجيدة عن نوع الاجهزة التي تستخدم لمراقبة الدورة الدموية الغازية وحوالي ثلث العينه فقط لديهم المعرفه الكافيه عن دواعي استخدام هذه الاجهزة و دواعي استعمال مراقبة ضغط الدم . وجدت هذه الدراسة ان الخبره والمؤهل العلمي لديهم تأثير علي معرفة الممرضين والممرضات تجاه اجهزة مراقبة الدورة الدموية الغازية لمرضى القلب بالعناية الحثيثه، و50% من عينة الدراسة يرى ان القصور في وجود كوادر مؤهلة السبب في قلة معرفتهم . خلصت الدراسة إلي أن معرفة الممرضين والممرضاتلاجهزة مراقبة الدورة الدموية الغازية لمرضى القلب بالعنايه الحثيثة غير مقبول.أوصت الدراسة بعمل برامج تدريبيهدورية للممرضين والممرضات لمعرفة اجهزة مراقبة الدورة الدموية الغازية ، وتصميم كتيبات عن مراقبة الدورة الدموية الغازية لمرضى القلب وتكون متاحة للممرضين والممرضات بالمستشفيات.وإلي ضرورة الإشراف المستمر علي الممرضين والممرضات من حيث فعاليتهم لتأكيد الجودة.

LIST OF COTENTS

ABBREVIATIONS

BP	Blood Pressure
CVP	Central Venous Pressure
CVC	Central Venous Catheter
CDC	Centers for Disease Control
CCU	Coronary Care Unite
EF	Ejection Fraction
HR	Heart Rate
HF	Heart Failure
HDU	High Dependent Unit
ICU	Intensive Care Unit
IV	Intra Venous
IHDM	Invasive Hemodynamic Monitoring
LVEDP	Left Ventricular End Diastolic Pressure
LAP	Left A trial Pressure
MAP	Mean Arterial Pressure
NIBP	Non Invasive Blood Pressure
PWP	Pulmonary Wedge Pressure
PVR	Peripheral Vascular Resistance
PICC	Peripheral Inserted Central Line
PAOP	Pulmonary Artery Occlusion Pressure
PAWP	Pulmonary Artery Wedge Pressure
RAP	Right A trial Pressure
SV	Stroke Volume
SVO2	Mixed Venous Oxygen Saturation
SA	Sino A trial
SVR	Systemic Vascular Resistance

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CHAPTER ONE

INTRODUCTION, JUSTIFICATION &OBJECTIV

1.1.Background:

Hemodynamic is the study of the interrelationship of blood pressure (BP), blood flow, vascular volumes, heart rate, ventricular function, and the physical properties of the blood. Monitoring the hemodynamic status of the critically ill patient is an integral part of critical care nursing It is essential that critical care nurses have a working knowledge of how to obtain accurate data, analyze waveforms, and interpret and integrate the data.(1)

Monitoring should be selected and applied to detect patho physiologic abnormalities in patients at high risk of developing them and to aid in the titration of therapy to appropriate physiologic end points and it is one of the cornerstones of patient evaluation in the intensive care unit (2,3).Provides information at the bedside about intra cardiac and intravascular pressures and cardiac output. It is used in the critical care setting to assess cardiac function and evaluate the effectiveness of therapy (4).Invasive hemodynamic monitoring is one of the major competencies required for the critical care nurses, moreover, monitoring parameters and insurance of the accuracy of the invasive system are the crucial in providing high quality nursing care in the ICUs(5). Hemodynamic monitoring is the use of monitoring devices to measure cardiovascular function, monitoring positively affect patient care and the practitioner must be able to interpret the data in the clinical setting, separate data from artifact, and conceptualize the physiologic, biochemical, or pharmacologic basis for the changes observed(6). Studies repeatedly have shown that physicians and nurses do not have strong knowledge of the principles of measurements; also the location of the proper place for measurement on the actual waveform can also be a source of error.(7)

1.2 .Problem statement:

Invasive hemodynamic monitoring is one of the major competencies required for the critical care nurse. Evidence has shown that this type of hemodynamic monitoring needs specific abilities in knowledge and practice, therefore increasing these nursing capabilities will increase the level of the patients' care, this fact was proved by a study that was carried out in 2014 in the Sudanese governmental hospital’s cardiac surgery intensive care units that have recommended that ICU nurses need in service training programs due to their fair in knowledge and practice.(7)

1.3 .Justification

Nurses are in key position to disseminate knowledge and proved proper nursing care for patient in intensive care units, this patient have a continuous infusion of medications that support the hemodynamic status of him such as vasodilators, vasopressors, etc. Such drugs need continuous observation of the parameters especially the invasive blood pressure. the nurses knowledge about invasive hemodynamic monitoring it is very important to prevent patient deterioration and complication because he or she is staying with the patient all day. Moreover studies repeatedly have mentioned that physicians and nurses do not have strong knowledge of the principles of measurement of hemodynamic problems.(9)

1.4 .Objectives:

1.4.1 .General Objective:

To assess nurses knowledge regarding invasive hemodynamic monitoring for critical care nurses' in Sudan heart center

1.4.2 .Specific Objectives:

To identify the relationship between the demographic data and the study variables.

To assess nurses knowledge regarding invasive hemodynamic monitoring.

To assess barriers and influencing factors affecting hemodynamic monitoring .

CHAPTER TWO

LITERATURE REVIEW

2-1. Definition

Hemodynamic monitoring is the use of monitoring devices to measure cardiovascular function, monitoring to positively affect patientcare, the practitioner must be able to interpret the data in the clinical setting,separate data from artifact, and conceptualize the physiologic, biochemical, orpharmacologic basis for the changes observed. Provider education and knowledge have a tremendous effect on patient outcome when technology such as thepulmonary artery catheter is used in critical care diagnostic and therapeutic decision making[5, 6].

The primary purpose of invasive hemodynamic monitoring is the early detection, identification, and treatment of life-threatening conditions such as heart failure and cardiac tampanade. By using invasive hemodynamic monitoring the nurse is able to evaluate the patient's immediate response to treatment such as drugs and mechanical support. The nurse can evaluate the effectiveness of cardiovascular function such as cardiac output, and cardiac index.The nurse cares for the hemodynamic unstable patient as well as the equipment required to conduct hemodynamic monitoring. It is essential that the nurse be able to interpret the data and make clinical decisions based on that data. The nurse must know how to detect and prevent complications of this clinical tool[8].

2-2. the indications of invasive hemodynamic monitoring include:

- All shock state(cardiogenic, anaphylactic, septic, hypovolemic and nurogenic).
- Loss of cardiac function.
- Decrease of cardiac output.

2-3. Hemodynamic Concepts:

The critical care nurse should recognize and understand the building blocks of hemodynamic.

These building blocks include:

- Heart rate
- Stroke volume
- Cardiac output
- Blood pressure/Systemic vascular resistance/Pulmonary vascular resistance
- Central venous pressure/Pulmonary wedge pressure
- Determinants of stroke volume

o Preload

o Afterload

o Contractility

- Mixed venous oxygen saturation (SVO2)[9].

2-4. cardiopulmonary anatomy and physiology:

In this section, a review of functional cardiac anatomy and applicable physiology is presented. These concepts provide the foundations of hemodynamic monitoring.When discussing the functional anatomy of the heart in regards to hemodynamic monitoring, the heart is described as two separate pumps. Each side, or pump, has its own function and pressure generation. For this reason, the terms right and left heart are used. Acting as a single unit, the right heart consists of the right atrium and right ventricle [10]. The right heart's main function is to receive deoxygenated venous blood into the right atrium. From there, the right ventricle needs to generate only a minimal amount of pressure to pump the blood through the pulmonic valve into the pulmonary circulation. It is because of this that the right heart is considered a low pressure system. The left heart is a similar unit which receives oxygenated blood from the pulmonary system. The left heart is considered a high pressure system since the left ventricle needs to generate a greater amount of pressure to pump blood through the aortic valve, into the aorta, and then through the systemic circulation. The pulmonary capillary bed lies between the right and left heart. The capillary bed is a very compliant system with a high capacity to hold blood. Changes in this capacity can be detected through pressure changes seen for both sides of the heart. The circulatory system therefore consists of two circuits in a series: pulmonic circulation, which is a low-pressure system with low resistance to blood flow; and the systemic circulation, which is a high-pressure system with high resistance to blood flow. Hemodynamic events are classified as either systolic or diastolic. By convention, the terms usually depict ventricular activity. The atria have phases of systole and diastole as do the ventricles. Technically speaking, the left side of the heart is the first to begin and complete the systolic and diastolic phases. For ease of discussion and since the time difference is minimal, we will consider the right and left sides to function at the same time [(10).]

2-4-1. Cardiac Cycle

The first type of cardiac cycle that must occur is the electrical cardiac cycle [(10).] The initial phase is depolarization, which begins from the sinus node and spreads a wave of electrical current throughout the atria. This current is then transmitted throughout the ventricles. Following the wave of depolarization, muscle fibers contract; that produces systole. The next electrical activity is repolarization which results in the relaxation of the muscle fibers and produces diastole. In the normal heart, initial electrical activity produces the mechanical activity of systole and diastole. There is a time difference between the two called electro-mechanical coupling orthe excitation-contraction phase [10]. When looking at a simultaneous recording of the electrocardiogram (ECG) and pressure tracing, the ECG will show the appropriate wave before the mechanical tracings will.

Cardiac performance has four fundamental components: heart rate, preload, Afterload, and contractility. In a diseased heart or altered circulatory system state, one or more of these determinants may be affected or altered in an attempt to maintain adequate cardiac performance[10].

2-4-2. Cardiac Output

Cardiac output refers to the amount of blood pumped by each ventricle during a given period. The cardiac output in a resting adult is about 5 L/min but varies greatly depending on the metabolic needs of the body. Cardiac output is computed by multiplying the stroke volume by the heart rate [10].

2-4-3.Stroke volume

The amount of blood ejected per heartbeat. The average resting stroke volume is about70 ml, and the heart rate is 60 to 80 b pm. Cardiac output can be affected by changes in either stroke volume or heart rate. Cardiac output must be responsive to changes in the metabolic demands of the tissues. For example, during exercise the total cardiac output may increase fourfold, to 20 L/min. This increase is normally accomplished by approximately doubling both the heart rate and the stroke volume. Changes in heart rate are accomplished by reflex controls mediated by the autonomic nervous system, including its sympathetic and parasympathetic divisions. The parasympathetic impulses, which travel to the heart through the vagus nerve, can slow the cardiac rate, whereas sympathetic impulses increase it [10]. These effects on heart rate result from action on the SA node, to either decrease or increase its inherent rate. The balance between these two reflex control systems normally determines the heart rate. The heart rate is increased by the sympathetic nervous system through an increased level of circulating catecholamine's (secreted by the adrenal gland) and by excess thyroid hormone, which produces a catecholamine like effect. In addition, the heart rate is affected by central nervous system and Baroreceptors activity. **Baroreceptors** are specialized nerve cells located in the aortic arch and in both right and left internal carotid arteries (at the point of bifurcation from the common carotid arteries). The Baroreceptors are sensitive to changes in blood pressure (BP). During significant elevations in BP **(**hypertension**),** these cells increase their rate of discharge, transmitting impulses to the cerebral medulla. This initiates parasympathetic activity and inhibits sympathetic response, lowering the heart rate and the BP. The opposite is true during hypotension(low BP). hypotension results in less Baroreceptors stimulation, which prompts a decrease in parasympathetic inhibitory activity in the SA node, allowing for enhanced sympathetic activity. The resultant vasoconstriction and increased heart rate elevate the BP. Control of Stroke Volume [11]**.**

Stroke volume is primarily determined by three factors:

Preload, after load, and contractility.

2-4-3-1. Preload

refers to the degree of stretch of the ventricular cardiac muscle fibers at the end of diastole. The end of diastole is the period when filling volume in the ventricles is the highest and the degree of stretch on the muscle fibers is the greatest. The volume of blood within the ventricle at the end of diastole determines preload, which directly affects stroke volume. Therefore, preload is commonly referred to as left ventricular end-diastolic pressure (LVEDP). As the volume of blood returning to the heart increases, muscle fiber stretch also increases (increased preload), resulting in stronger contraction and a greater stroke volume. This relationship, called the Frank-Starling (or Starling) law of the heart, is maintained until the physiologic limit of the muscle is reached. The Frank-Starling law is based on the fact that, within limits, the greater the initial length or stretch of the cardiac muscle cells (sarcomeres), the greater the degree of shortening that occurs. This result is caused by increased interaction between the thick and thin filaments within the cardiac muscle cells. Preload is decreased by a reduction in the volume of blood returning to the ventricles. Diuresis, venodilating agents (e.g., nitrates), excessive loss of blood, or dehydration (excessive loss of body fluids from vomiting, diarrhea, or diaphoresis) reduce preload. Preload is increased by increasing the return of circulating blood volume to the ventricles. Controlling the loss of blood or body fluids and replacing fluids (i.e., blood transfusions and intravenous [IV] fluid administration) are examples of ways to increase preload(12).

2-4-3-2. Afterload

Afterload, or resistance to ejection of blood from the ventricle, is the second determinant of stroke volume. The resistance of the systemic BP to left ventricular ejection is called systemic vascular resistance. The resistance of the pulmonary BP to right ventricular ejection is called pulmonary vascular resistance. There is an inverse relationship between afterload and stroke volume. For example, afterload is increased by arterial vasoconstriction, which leads to decreased stroke volume. The opposite is true with arterial vasodilatation: After load is reduced because there is less resistance to ejection, and stroke volume increases[12].

2-4-3-3. Contractility

refers to the force generated by the contracting myocardium. Contractilityis enhanced by circulating catecholamine, sympathetic neuronal activity, and certain medications (e.g., digoxin [Lanoxin], dopamine [Intropin], or dobutamine [Dobutrex]). Increased contractility results in increased stroke volume[11]. Contractility is depressed by hypoxemia, acidosis, and certain medications (e.g., beta-adrenergic blocking agents such as atenolol [Tenormin]). The heart can achieve an increase in stroke volume (eg, during exercise) if preload is increased (through increased venous return), if contractility is increased (through sympathetic nervous system discharge), and if after load is decreased (through peripheral vasodilatation with decreased aortic pressure). The percentage of the end-diastolic blood volume that is ejected with each heartbeat is called the **ejection fraction**. The ejection fraction of the normal left ventricle is 55% to 65%. The right ventricular ejection fraction is rarely measured. The ejection fraction is used as a measure of myocardial contractility. An ejection fraction of less than 40% indicates that the patient has decreased left ventricular function and likely requires treatment for heart failure (HF) [11].

2-5. the pressure monitoring system:-

Invasive monitoring requires the vascular system to be cannulated and pressure or flow within the circulation interpreted.

2-5-1. Invasive hemodynamic monitoring technology includes:

- systemic arterial pressure monitoring
- central venous pressure
- pulmonary artery pressure
- cardiac output (thermo dilution).

Invasive monitoring has also facilitated greater use of blood component analyses, such as arterial and venous blood gases. The invasive nature of this monitoring allows the pressures that are sensed at the distal ends of the catheters to be transduced, and to continuously display and monitor the corresponding waveforms. The extent of monitoring should reflect how much information is required to optimize the patient's condition, and how precisely the data are to be recorded[(13).]

2-6. PRINCIPLES OF HEMODYNAMIC MONITORING

A number of key principles need to be understood in relation to invasive hemodynamic monitoring of the critically ill patients. These include hemodynamic accuracy, the ability to trend data and the maintenance of minimum-standards[(13).]

2-6-1. Hemodynamic Accuracy

Accuracy of the value obtained from hemodynamic monitoring is essential, as it directly affects the patient's condition.

Electronic equipment for this purpose has four components:

1. invasive catheters attached to high-pressure tubing
2. a transducer to detect physiological activity
3. a flush system
4. a recording device, incorporating an amplifier to increase the size of the signal, to display information. High-pressure (non-distensible) tubing reduces distortion of the signal produced between the intravascular device and the transducer; the pressure is then converted into electrical energy (a

waveform). Fluid (0.9% sodium chloride) is routinely used to maintain line patency using a continuous pressure system; the pressure of the flush system fluid bag should be maintained at 300 mmHg, which normally delivers a continual flow of 3 ml/h. Accuracy is dependent on leveling the transducer to the appropriate level (and altering this level with changes in patient position as appropriate), then zeroing the transducer in the pressure monitoring system to atmospheric pressure (called calibration) as well as evaluating the response of the system by fast-flush wave testing. The transducer must be leveled to the reference point of the phlebostatic axis, at the intersection of the 4th intercostals space and the midthoracic anterior-posterior diameter (not the midaxillaries line).Error in measurement can occur if the transducer is placed above or below the phlebostatic axis.Measurements taken when the patient is in the lateral position are not considered as accurate as those taken when the patient is lying supine or semi recumbent up to an angle of approximately 60 degrees.Zeroing the transducer system to atmospheric pressure (calibration of the system) is achieved by turning the 3-way stopcock nearest to the transducer open to the air, and closing it to the patient and the flush system. The monitor should display zero (0 mmHg), as this equates to current atmospheric pressure (760 mmHg at sea level). With the improved quality of transducers, repeated zeroing is not necessary, as once zeroed, the drift from the baseline is minimal.Some critical care units, however, continue to recalibrate transducer at the beginning of each clinical shift. Fast-flush square wave testing or dynamic response measurement is a way of checking the dynamic response of the monitor to signals from the blood vessel. It is also a check on the accuracy of the subsequent hemodynamic pressure values. The fast-flush device within the system, when triggered and released, exposes the transducer to the amount of pressure in the flush solution bag (usually 300 mmHg). The pressure waveform on the monitor will show a rapid rise in pressure, which then squares off before the pressure drops back to the baseline[12].

Interpretation of the square wave testing is essential; the clinician must observe the speed with which the wave returns to the baseline as well as the pattern produced. One to three rapid oscillations should occur immediately after the square wave, before the monitored waveform resumes. The distance between these rapid oscillations should not exceed 1 mm or 0.04 sec.Absence, or a reduction, of these rapid oscillations, or a 'square wave' with rounded corners, indicates that the pressure monitoring system is over damped; in other words its responsiveness to monitored pressures and waveforms is reduced. An under damped monitoring system will produce more rapid oscillations after the square wave than usual[13].

2-7. Intra arterial pressure monitoring:

2-7-1. **Definition**

Invasive arterial blood pressure monitoring is measuring thearterial blood pressure by a device inserted into the circulation of a patient.

2-7-2. Aims and indications

an invasive arterial blood pressure system enables beattobeat, continuous measurement of blood pressure. It alsoprovides some indication of cardiac contractility through the slope of the upstroke on the arterial pressure waveform, where the more vertical the upstroke better the contractility . Invasive arterial blood pressure monitoring is indicated in those patients who:

require inotropic or vasopressor drug support so rapid titration of blood pressure can be achieved.

are likely to have significant changes in circulating blood volume either through blood loss or movement of fluid between body fluid compartments.

require frequent arterial blood gas measurement to guide ventilator management or to monitor acidbase balance[12].

Invasive blood pressure monitoring is achieved by the insertion of a cannula, usually 20G in size, into an artery of a patient. The artery most commonly used is the radial but the brachial, femoral and dorsal paddies are also used . The cannula is attached to a pressure monitoring system consisting of a bag of fluid (usually 0.9% sodium chloride) in a pressure bag set to 300mmHg (which is commonly called the flush bag), an infusion set and pressure transducer[13.14].

2-7-3. Evidence and current debates

2-7-3-1. Choice of method of monitoring

Invasive blood pressure monitoring is thought to be more accurate than noninvasive measurement performed using oscillometry, particularly in the critically ill . This is because oscillometry tends to overestimate low pressures (less than 60mmHg) and underestimate high pressures, and it is these extremes of pressure that are more common in the critical care setting. In normotensive patients, oscillometry provides 95% confidences interval of±15mmHg. Oscillometry is also less accurate in those patients with arrhythmias due to the potentially wide variety of pressures between beats[13.14].

2-7-3-2.Use of heparin in a pressured 'flush bag'

The pressure monitoring system used in measuring arterial blood pressure invasively contains a pressurized bag of 0.9% sodium chloride (flush bag). Previously, 2–3units of heparin per ml of 0.9% sodium chloride were added to the flush bag to reduce the risk of thrombosis of the arterial cannula. Following concerns that the addition of heparin to the 0.9% sodium chloride may increase the risk of patients developing coagulpathy, research was undertaken to establish whether 0.9% sodium chloride alone in the flush bag was just as effective at maintaining patency of the arterial cannula as when heparin was added. It has been shown that there is no increase in the incidence of arterial cannula thrombosis with the use of 0.9% sodium chloride compared with heparin zed 0.9% sodium chloride. In addition, patients were shown to be at risk of developing heparininduced thrombocytopenia following exposure to heparin in the 0.9% sodium chloride. It is now common practice for 0.9% sodium chloride to be used without the addition of heparin to the flush bag[(14).]

2-7-4. Insertion of and monitoring using an invasive blood pressure monitoring system

Prior to insertion of the arterial cannula, the pressure monitoring system should be prepared. This consists of a 500mLbag of 0.9% sodium chloride attached to a specific infusion set containing a pressure transducer. The bag of 0.9% sodium chloride is placed inside a pressure bag that is inflated to 300mmHg (the 'flush bag') . When attached to the arterial cannula this maintains a flow of 3mL/h of 0.9% sodium chloride to prevent thrombosis of the system. The infusion set usually contains a three-way tap near the arterial cannula to allow blood samples to be taken. The appropriate site for arterial cannulation is then chosen (usually the radial artery)(14).

Performing the modified Allen's test to establish whether the ulnar artery is able to provide adequate blood flow when the radial artery is cannulated is a matter of debate. Its value in assessing how likely a patient is to suffer ischemic complications from insertion of a radial arterial cannula are not proven. To perform a modified Allen's test the patient is asked to clench and unclench their fest several times while both the radial and ulnar arteries are occluded by pressure at the wrist. The hand is then unclenched (which should have blanched) and pressure released from the ulnar artery. The time taken for the hand to regain its normal color is recorded. The value of this figure is also a matter for debate with figures from 3 to 15 seconds described as demonstrating adequate blood flow in the ulnar artery(14).

The insertion of the cannula is performed using an aseptic technique. The artery to be cannulated is located by palpation of the pulse and is cannulated using a device similar to an intravenous cannula or by passing a guide wire through a needle that has located the artery and threading the cannula over the guide wire into the artery. The cannula is then connected to the pressure monitoring system. There is a connector that comes from the pressure transducer, allowing it to be connected via a cable to the monitor. Once the system is connected to the monitor an arterial waveform should appear on the monitor(6).

To allow an accurate recording of the blood pressure to be obtained, the pressure transducer should be at the same level as the patient's right atrium and then calibrated (or 'zeroed'). This involves turning the tap at the transducer so it is 'off to the patient and open to air'. A these mean the fluid from the flush bag no longer goes down to the cannula but is directed to the opening in the tap to air. A button on the monitor is pressed to calibrate the system to zero and when this is achieved the tap is returned to its usual position. The monitor will now display the arterial waveform and the numerical readings for systolic, diastolic and mean blood pressure. Appropriate alarm limits for the patient should be set for these parameters. For example, if the systolic pressure is less than 90mmHg or the mean pressure less than 60mmHg. If there is thrombus or air in the pressure monitoring system or the flush bag has deflated, then the arterial waveform will appear damped[(15)].

A damped appearance is when the waveform has a more rounded appearance, with the peak of the pressure trace not as sharp. The appearance of the arterial waveform also provides data about myocardial contractility. A rapid rise in the upstroke of the arterial waveform indicates good contractility whereas a slower rise may indicate the need for inotropic support. If the diacritic notch (point where the aortic valve closes) is low on the down stroke this indicates the patient may be vasodilator [(15).]

2-7-5. Complications related to arterial catheters:

Arterial cannulation is relatively safe. Risks depend on site of cannulation. For radial cannulation, reported serious risks include permanent ischemic damage (0.09%), local infection and sepsis (0.72% and 0.13%, respectively), and pseudo aneurysm (0.09%). Fastidious attention to the adequacy of distal perfusion is of great importance. Thrombotic squeal are associated with larger catheters, smaller arterial size, administration of vasopressors, duration of cannulation, and multiple arterial cannulation attempts. With regard to infectious risk, aseptic technique was not standardized in the studies that yielded the aforementioned percentage of risk, and longer duration of cannulation increased risk. Less serious risks include temporary occlusion (19.7%) and hematoma (14.4%). Auxiliary and femoral sites are associated with higher risks of infection. Brachial cannulation has been associated with median nerve injury (0.2%–1.4%) (16).

2-7-6. Nursing considerations

• Explain the procedure to the patient and his family, including the purpose of arterial pressure monitoring.
• After catheter insertion, observe the pressure waveform to assess arterial pressure.

• Assess the insertion site for signs of infection, such as redness and swelling. Notify the practitioner immediately if you note such signs.
• Maintain 300 mm Hg pressure in the pressure bag to allow a flush flow of 3 to 6 ml per hour.

• Document the date and time of catheter insertion, catheter insertion site, type of flush solution used, type of dressing applied, and patient's tolerance of the procedure(17).

2-7-7. Removal of the arterial line:

The catheter may need to be removed. It is within the registered nursesscope of practice to discontinue or remove an arterial line.

The procedure is as follows:

1. Confirm physician order.
2. Verify patient identity via two identifiers.
3. Review patient's coagulation and hematology results.

4. Provide patient and family education.

5. Put on necessary PPE.

6. Remove dressing.

7. Aspirate 3–5 ml of blood from the port into a syringe; leave syringe attached.

8. Apply pressure 1 to 2 finger widths above catheter insertion site.

9. Remove catheter in one swift stroke, noting if catheter tip is intact.

10. Apply pressure to site with a sterile 4 × 4.

11. Hold pressure until homeostasis; 5 to 10 minutes, or longer if needed.

12. Apply a transparent dressing to site. Do not wrap dressing circumferentially around the wrist. No pressure dressing is needed.

13. Limit patient activity with associated limb for approximately 1 hour.

14. Continue to monitor BP with an NIBP assess the site frequently for a palpable pulse, bleeding, ecchymosis, changes in skin color, coolness of the extremity, and patient complaints of numbness or tingling. document education,procedure, and patient tolerance [17].

2-8. CENTRAL VENOUS PRESSURE MONITORING

Central venous pressure reflects right a trial filling pressure and aids assessment of intraventricular volume and right- sided heart function. Readings are dependent on cardiac function, intravascular volume, vascular tone, intrinsic venous tone, increased intra - abdominal or intrathoracic pressures, and vasopressor therapy. The normal CVP is 3 – 8 cmH2O or 2-6mmHg. A low CVP reading usually indicates hypovolaemia whereas a high CVP reading has a numberof causes, including hypervolaemia, cardiac failure and pulmonary embolism[18].

2-8-1. Indications for central venous catheters

Indications for central venous catheters include:

• Rapid fluid resuscitation
• Drug and fluid administration, e.g. parenteral nutrition
• Chronically ill patients, who will usually have a peripherally inserted central line (PICC)
• Measurement of central venous pressure
• Poor venous access
• Cardiac pacing
• Post insertion of a pulmonary artery catheter (same site

Central venous catheters are frequently used in the management of critically ill patients for both monitoring and administration ofdrugs and fluids. The usual sites for insertion of central venous catheters are internal jugular (right and left) and subclavian veins(right or left). The latter is often the preferred site. Although the subclavian has more recognizable landmarks to help the clinicianand associated with lower risks of infection compared to other sites, there are fewer risks associated with the insertion at theinternal jugular. The femoral vein is sometimes used but generally only as a last resort because of the increased risk of infection.Central venous catheters can consist of one, three, four or five Lumina and choice is dependent upon the severity of the patient'scondition and their prime use. Strict asepsis must be adhered to on insertion and during on - going management because migration of skin organisms at the insertion site or direct contamination of the catheter hub by hand contact, contaminated fluids or devices is the source of most catheter - related bloodstream infections[18].

There is recent evidence to suggest that antimicrobial – impregnated central venous catheters may reduce the risk of catheter – related bloodstream infections. The most potent of these antimicrobials is silver but other agents have been reported such as antibiotics, e.g. rifampicin and minocycline, and antiseptic agents, e.g. chlorhexidine and silver sulfadiazine. Central venous pressure monitoring can be helpful in the assessment of cardiac function, circulating blood volume, vasculartone and the patient' s response to treatment[18].

However, CVP can be influenced by a number of factors and should therefore beinterpreted together with other systemic measurements. An isolated CVP measurement can be misleading; a trend in readings will demonstrate response to treatment and/or disease progression and is therefore of more value. To help ensure validity of the measurements and accuracy of their interpretation, the patient's position should be constant (supine if possible) and the same point of reference (phlebostatic axis) should be used for each reading[18].

2-8-2. Methods of CVP monitoring

2-8-2-1. **Manometer system:** CVP manometers are no longer used in clinical practice. If a patient's condition necessitates CVP monitoring they should bemanaged in a higher level of care, i.e. HDU or ICU, where electronic monitoring of invasive pressures is routinely undertaken [18]. enables intermittent readings, but is less accurate than the transducer system and infrequently used.

2-8-2-2.**Transducer system**: enables continuous readings that are displayed on a monitor.

2-8-3. CVC Insertion procedure;

Because many patients are awake and alert, also it is sterile procedure, supine or trendelenburg position is required, a brief explanation of the procedure will minimize patient anxiety and result in co-operation during the procedure, ECG should be monitored during the insertion because of associate risk of dysrhythmias(19).

All central line are designed for placement by percutaneous injection after skin preparation and administration of local anesthetic, usually prepackaged CVC kit is used for the procedure. The stander CVC kit contains sterile towels, chlorhexidine, and alcohol skin prep, a needle introduce, a syringe, guide wire, and a catheter r. The slinger technique is the preferred method. After thoracic CVC placement, a chest radiograph is obtained to confirm the procedure success and exclude mal positioning, pneumothorax or hem thorax formation. Use of Doppler ultrasound guidance to find the vein and guide insertion may reduce the incidence of latrogenic complication (19).

2-8-4. Complications

Infection

Infection may occur intravascular or around the insertion site. Signs and symptoms of central venouscatheter–associated infection may include erythema at the insertion site, fever, or an elevated white blood cell (WBC) count. Definitive diagnosis is obtained with blood cultures.

Primary measures to preventinfection include routine dressing and IV fluid tubing changes (per Centers for Disease Control andPrevention [CDC] guidelines and facility protocol) and adherence to sterile technique during catheterinsertion and dressing changes(4).

Thrombosis

Thrombi occasionally form and may vary from a thin layer of fibrin over the catheter tip to a largethrombus. Loss of the hemodynamic waveform or the inability to infuse fluid or withdraw blood fromthe catheter may be indications that the catheter is occluded by a large thrombus. Because a thrombus may mobilize (putting the patient at risk for pulmonary embolism) or impair circulation to a limb,it constitutes an emergency and must be reported to the physician immediately. Facility protocolmay permit nurses to attempt aspirating the clot. Frequently, facilities also have protocols to administer small doses of thrombolytic agents to dissolve the clot[4, 26].

Pneumothorax

Anatomical factors can make placement of a central line difficult, particularly if the patient is obeseor has torturous subclavian veins. The needle or introducer sheath may pass through the vessel walland puncture the lung during insertion, causing an apical pneumothorax. A postinsertion chest radiograph is routinely obtained to verify proper catheter placement and assess for pneumothorax. Signs and symptoms of a pneumothorax include pleuritic chest pain, shortness of breath and dyspnea, asymmetrical chest wall movement, diminished orabsent breath sounds, tachycardia, and elevated peak inspiratory pressures (if the patient is receiving mechanical ventilation)[4].

Air Embolism

Air embolism occurs as a result of air entering the vasculature and traveling through the vena cava tothe right ventricle. When the tubing is disconnected from the catheter, changes in intrathoracic pressure with inspiration and expiration can draw air into the catheter[4, 26].

Approximately 10 to 20 ml of air entering the venous system can cause the patient to become symptomatic. Signs and symptoms include sudden hypotension, confusion, lightheadedness, anxiety, and unresponsiveness. Cardiac arrest may occur if the air bolus is large. If air embolism is suspected, turning the patient on the left side in the Trendelenburg position may allow the air to rise to the wall of the right ventricle and improve blood flow. Supplemental oxygen is started unless contraindicated [4, 26].

2-8-5. REMOVAL OF THE CENTRAL VENOUS CATHETER

It has been, and sometimes still is, routine policy in some institutions to change all central venous lines placed in the Emergency Department when the patient arrives in the Intensive Care Unit. It was believed that these lines placed in the Emergency Department were “dirty” and at a higher risk of infection. This practice results in an additional procedure, the additional time and cost of the procedure, the associated discomfort or pain of the procedure, andthe potential for complications[20].

A recent study demonstrated that the infection rate of central venous lines placed in the Emergency Department using aseptic technique was no different than those placed in the Intensive Care Unit. When removing a central venous catheter from the internal jugular or subclavian vein, place the patient in the Trendelenburg position. To remove a femoral vein catheter, place the patient supine. Remove the dressing overlying the skin puncture site. Cut the suture securing the catheter to the skin. Ask the patient to exhale and hold their breath. Briskly remove the catheter and cover the puncture site with a gauze dressing. The track from the skin surface to the vein can be a source of a fatal venous air embolism.58 If the catheter had a large diameter or remained in place for more than 2 to

3 days, apply an occlusive dressing to the site for the first 1 to 2 days after the catheter has been removed. The skin puncture site should be observed for signs of infection twice a day for 48 hours [20].

2-9. Pulmonary Artery Pressure monitoring

pulmonary artery pressure (PAP) monitoring, a catheter is placed through the right side of theheart into the pulmonary artery. By measuring pressures in the right atrium, right ventricle, andpulmonary artery, it is possible to assess right ventricular function, pulmonary vascular status, and,indirectly, left ventricular function. The pulmonary artery catheter (PAC) also allows evaluation of cardiac output[14].

2-9-1. Equipment and Setup Pulmonary Artery Catheter

Several types of PACs are available. The type of catheter used is determined by the parameters to bemonitored. All PACs have multiple external lumens[14].

A typical PAC has four lumens:

• The distal lumenis located into the pulmonary artery and is attached to the transducer to measurePAPs. Mixed venous blood (used to calculate mixed venous oxygen saturation [SvO2], oxygen extraction, oxygen consumption, and intrapulmonary shunt measurements) may be withdrawn from the distal lumen. Use of the distal lumen for administering fluid or medication is not recommended[14].

• The proximal lumenterminates in the right atrium or the superior vena cava. The lumen is used for infusing fluids and is often connected to a transducer to provide RAP measurements and display of the RAP waveform. The proximal lumen is also used to inject solution for cardiac output measurement[14].

• The thermistorreceives input from a thermistor on the tip of the PAC and measures the patient'score temperature. It detects the blood temperature change when solution is injected through the proximal lumen during cardiac output measurements[13].
• The balloon inflation lumenis used to inflate the balloon near the catheter tip with air. Inflationof the balloon causes the catheter to occlude (or wedge) into a distal artery, allowing measurement of the pulmonary artery occlusion pressure (PAOP), formerly known as the pulmonary artery wedge pressure (PAWP). Fluid is never inserted into the balloon inflation lumen. It is an indirect measurement of LAP (13). Specialty PACs have additional lumens and capabilities. For example, a five-lumen catheterhas an additional lumen for venous infusion into the right atrium. A seven-lumen catheter includes anadditional lumen for venous infusion, as well as an optical module lumen (which connects to a specialoximetry monitor for SvO2 monitoring) and a thermal filament lumen (which allows display of cardiacoutput on a continuous basis). Another type of specialty PAC determines right ventricular volumes, andthen calculates the right ventricular ejection fraction[14].

2-9-2.Pulmonary Artery Catheter Insertion

The nurse assists with PAC insertion.2 Strict sterile technique is required. The physician inserts thePAC through a large vein, usually the right internal jugular, the right or left subclavian, or the femoralvein. The physician advances the catheter with the balloon inflated once it is in the right atrium. Todetermine catheter tip location, the nurse monitors the waveforms and pressures on the bedside monitor as the catheter passes into the right atrium, through the tricuspid valve into the right ventricle, across the pulmonic valve, into the pulmonary artery, and eventually into the wedged position. The balloon is allowed to deflate passively after the pulmonary artery wedge is noted on the monitor and the return of the pulmonary artery is confirmed[6].

The amount of air required to ‘wedge’ the balloon is noted. The PAC is secured, a sterile dressing is placed over the insertion site, and a chest radiograph is obtained to verify catheter position. The distal (pulmonary artery) lumen is connected to pressure tubing, and the other lumens are connected as appropriate, either to the pressure monitoring system or an IV solution. If the PAC is not properly secured, it may become dislodged and the tip may “fall back” into the right ventricle. The patient may experience dysrhythmias (as a result of endocardial irritation by the cathetertip), and the hemodynamic pressures and waveform will reflect those of the right ventricle instead of the pulmonary artery. Inflating the balloon may cause the catheter to “refloat” into the pulmonary artery. Alternatively, if the catheter is in a sleeve (to protect from contamination, it may be advanced into the proper position in the pulmonary artery[6, 14].

2-9-3. Data Interpretation

The pressures and waveforms obtained through PAP monitoring are generated by pressure changes in the heart that occur throughout the cardiac cycle. The mechanical activity of the heart (ie, systole and diastole) follows the electrical activity of the heart. Therefore, mechanical activity must be correlated to electrical activity by interpreting the hemodynamic waveforms alongside an electrocardiographic tracing. Interpretation of pressure measurements obtained through PAP monitoring. Measurement of all pressures is most accurate when obtained at the end of expiration. During the end-expiration period, there is minimal airflow and little variation in pleural pressures that influence cardiac pressures. Thus, end expiration provides a standard reference point for obtaining measurements. Spontaneous breathing causes negative intrathoracic pressure during inspiration, which produces a decline in the waveform. The waveform used for measurement is the last clear wave occurring just before the inspiratory dip . Mechanical ventilation causes positive intrathoracic pressure during inspiration, which produces an inspiratory "push," or rise, in the waveform. In mechanically ventilated patients, the waveform used for measurement is the last clear wave occurring just before the inspiratory rise[(4)].

2-9-4. Complications

Generally, most complications that occur with PAP monitoring relate to the need for percutaneous central venous access. Complications such as infection, thrombus, pneumothorax, and air embolus. Other complications that may occur with PAP monitoring include ventricular dysrhythmias, pulmonary artery rupture or perforation, and pulmonary infarction [(4, 22)].

2-9-5. Nursing considerations

• Inform the patient he'll be conscious during catheterizationand he may feel temporary local discomfort from the administration of the local anesthetic. Catheter insertion takes about 15 to30 minutes.
• After catheter insertion, you may inflate the balloon with asyringe to take PAWP readings. Be careful not to inflate the balloon with more than 1.5 cc of air. Over inflation could distend thepulmonary artery causing vessel rupture. Don't leave the balloonwedged for a prolonged period because this could lead to a pulmonary infarction.

• After each PAWP reading, flush the line; if you encounter difficulty, notify the practitioner.

• Maintain 300 mm Hg pressure in the pressure bag to allow a flush flow of 3 to 6 ml per hour.

• If fever develops when the catheter is in place, informs the practitioner; he may remove the catheter and send its tip to the laboratory for culture.

• Make sure stopcocks are properly positioned and connections secure. Loose connections may introduce air into the systemor cause blood backup, leakage of deoxygenated blood, or inaccurate pressure readings. Also make sure the lumen hubs are properly identified to serve the appropriate catheter ports.

• Because the catheter can slip back into the right ventricle andirritate it, check the monitor for a right ventricular waveform todetect this problem promptly. Be aware that running a continuousinfusion through the distal lumen will interfere with your ability tomonitor this waveform for changes.

• To minimize valvular trauma, make sure the balloon is deflatedwhenever the catheter is withdrawn from the pulmonary artery tothe right ventricle or from the right ventricle to the right atrium.

• Adhere to your facility's policy for dressing, tubing, catheter,and flush changes.

• Document the date and time of catheter insertion, the doctor who performed the procedure, the catheter insertion site,pressure waveforms and values for the various heart chambers,balloon inflation volume required to obtain a wedge tracing,arrhythmias that occurred during or after the procedure, type offlush solution used and its heparin concentration (if any), type of dressing applied, and the patient's tolerance of the procedure [22].

2-10. Nursing management regarding invasive hemodynamic monitoring:

Nurses caring for patients who require hemodynamicmonitoring receive training prior to using this sophisticated technology.

The following guidelines help ensure safe andeffective care:

• The nurse ensures that the system is set up and maintained properly. For example, the pressure monitoringsystem must be kept patent and free of air bubbles.•Before the system is used to obtain pressure measurements, the nurse checks that the stopcock of thetransducer is positioned at the level of the atrium. This landmark is referred to as the phlebostatic axis. The nurse uses a marker to identify thislevel on the chest wall, which provides a stable reference point for subsequent pressure readings.

• The nurse establishes the zero reference point in orderto ensure that the system is properly functioning atatmospheric pressure. This process is accomplished by placing the stopcock of the transducer at the phlebostatic axis, opening the transducer to air, and activating the zero function key on the bedside monitor. Measurements of CVP, BP, and pulmonary artery pressures can be made with the head of the bed elevatedup to 60 degrees, but the system must be repositionedto the phlebostatic axis to ensure an accurate reading.Complications from use of hemodynamic monitoringsystems are uncommon and can include pneumothorax, infection, and air embolism. The nurse observes for signsof pneumothorax during the insertion of catheters using central venous approach (CVP and pulmonary arterycatheters). The longer any of these catheters are left inplace (after 72 to 96 hours), the greater the risk of infection. Air emboli can be introduced into the vascular system if the stopcocks attached to the pressure transducersare mishandled during blood drawing, administration ofmedications, or other procedures that require opening thesystem to air. Therefore, nurses handling this equipmentmust demonstrate competence prior to independently caring for a patient requiring hemodynamic monitoring [11].

- Ensuring Accurate Waveform Transmission For hemodynamic monitoring to provide accurate information, the vascular pressure must be transmitted back to the transducer unaltered and then converted accurately into an electrical signal. For this waveform to be transmitted unaltered, no obstructions or distortions to the signal should be present along the transmission route. Distortion of the waveform leads to inaccurate pressure interpretations. A variety of factors can cause distortions to the waveform, including catheter obstructions (e.g., clots, catheter bending, blood or air in tubing), excessive tubing or connectors, and transducer damage. Verification of an accurate transmission of the waveform to the transducer is checked by the bedside nurse by performing a square wave test. This occurs at the beginning of each shift[1].

- Square Wave Test

  The square wave test is performed on all hemodynamic pressure systems before assuming that the waveforms and pressures obtained are accurate. The square wave test is performed by recording the pressure waveform while fast flushing the catheter. The fast-flush valve is pulled or squeezed, depending on the model, for at least 1 second and then rapidly released. The tracing should show a rapid rise in the waveform to the top of the graph paper, with a square pattern. Release of the flush device should show a rapid decrease in pressure below the baseline of the pressure waveform (undershoot), followed immediately by a small increase above the baseline (overshoot) prior to resumption of the normal pressure waveform. Square wave tests with these characteristics are called optimally damped tests and represent an accurate waveform transmission. The square wave test is the best method available to the clinician to check the accuracy of hemodynamic monitoring equipment. For example, if an arterial line is to be examined for accuracy, a square wave test should be done. Do not compare the arterial line pressure with an indirect blood pressure reading with a sphygmomanometer, because the indirect method is usually less accurate than the direct method (arterial line pressure). If the square wave test indicates optimal damping, then the arterial line pressure is accurate.Two problems may exist with waveform transmissions, and are referred to as over damping and underdampingover damping If something absorbs the pressure wave (like air or blood in the tubing, stopcocks, or connections), it is said to be over damped. over damping decreases systolic pressures and increases diastolic pressures. An over damped square wave test reflects the obstruction in waveform transmission. Characteristics of over damping include a loss of the undershoot and overshoot waves after release of the flush valve and a slurring of the down stroke(1).

- **Under damping**

If something accentuates the pressure wave (like excessive tubing), it is said to be under damped. under damping increases systolic pressuresand decreases diastolic pressures. An under damped square wave test reflects the amplification of pressure waves and includes large undershoot and overshoot waves after the release of the flush valve(1).

- **Care of the Tubing/Catheter System**

  Nosocomial infections related to the tubing/catheter system are usually caused by the entry of organisms through stopcocks. Stopcocks are opened for blood sampling and zeroing the transducer only when necessary. Closed, needleless systems are used whenever feasible to decrease the risks to the patient and clinician. Tubing changes, including flush device, transducer, and flush solution, should occur every 72 hours. The frequency of catheter device changes is controversial, but must occur whenever the catheter is suspected as a source of an IV infection or by institutional policy. Some clinicians believe it is safe to leave intravascular catheters in place until some sign of inflammation or infection develops. This approach may be safe, but it assumes more risk of developing catheter-related infection than the routine 4- to 5-day change guideline. Considering that the development of a single catheter-related infection can substantially increase the length of stay, it may be worthwhile to routinely change intravascular catheters. However, there is still a widespread variation in the practice of changing intravascular catheters at this time[(1)].

- **Alarms**

  Bedside monitors have alarms for each of the hemodynamic pressures being monitored. Normally, every parameter that is being monitored has high and low alarms, which can be set to detect variations from the current value. Alarm limits are generally set to detect significant decreases or increases in pressures or rates, typically ± 10% of the current values [(1).]

2-11. previous studies

A descriptive study was conducted on Hemodynamic monitoring and its practice over the past 30 years at North California among critically ill patients. Hemodynamic monitoring methods are of prime importance in diagnosis and management of critically ill patients therefore to ascertain whether nurses have enough knowledge a study was done in north California. The research which enrolled 200 nurses from 65 intensive care units, 170 nurses were eligible for analysis. The mean score of 63% was seen in over all 50 structured questionnaires. Study concluded that nurses had moderate knowledge on hemodynamic monitoring [(21).]

A study was conducted on understanding advanced hemodynamic concepts. A 200 critical care nurses in 10 intensive care units at 4 hospitals were to complete structured questionnaire on hemodynamic concepts and a demographic data sheet. The data from 4 components scores ranged from 20% to 50% correct answers, with a mean of 35.7%. Later guide sheet was administered and then a statistical result were analyzed and showed minor differences in score. The research concluded that steady improvement in knowledge and that training programme will help nurses to gain knowledge in advanced monitoring methods and recommended that study should be replicated on a larger scale to improve the standards of practice in hemodynamic monitoring. The study suggests that a new source of information and understanding helps and provides opportunities for nurses to ensure optimum patient outcomes [(22)] .

A study was conducted on expert critical care nurses' use of pulmonary artery pressure monitoring at Australia. Critical care nurses make numerous complex decisions during their day-to-day practice. General themes in previous decision-making studies have included the influence of knowledge and previous experience, the increasing complexity of decisions made and the change in decision-making processes used as the nurse progresses from a novice to an expert practitioner. Results indicated that pulmonary artery pressure monitoring was used to attain the concepts of preload, cardiac output and blood pressure. In addition, participants used few clinical assessment attributes, but collected a large number of attributes which they arranged around three to five central concepts and took a broad view of hemodynamic assessment. The study concluded that expert critical care nurses process an immense amount of data in a short space of time. However, they may not use all available data. Evidence suggests not all nurses who practice in the field for a lengthy period reach the level of an expert [(23).]

A study was conducted to Enhancing the accuracy of hemodynamic monitoring at Amsterdam. Assuring that critical care nurses have the skill and knowledge necessary to accurately utilize the many diagnostic monitoring functions available within critical care is essential for optimizing patient outcomes. This performance improvement project focused on the hemodynamic monitoring skills and knowledge level of the critical care nurses in both a cardiovascular and medical/surgical intensive care unit. A four-step progressive intervention strategy was initiated based on our pre-implementation assessment. Post-implementation measures demonstrated a substantial increase in the skill and knowledge level of the nurses [(24).]

Study was conducted on Invasive hemodynamic monitoring is one of the major competencies required for critical care nurses. Critically ill patients need continuous assessment of their cardiovascular system to diagnose and manage complex medical conditions. This study aimed to assess critical care nurses' knowledge and practice of invasive hemodynamic monitoring in Khartoum government hospitals. A descriptive study was conducted. It included ninety critical care nurses who worked in the Intensive Care Units (ICUs) of Khartoum government hospitals that have invasive hemodynamic monitoring system. The study extended from March 2013 to April 2014. Data were collected from ninety critical care nurses working in selected ICUs; using a validated questionnaire. The data were analyzed by the Statistical Package for Social Services Version 20. The results showed that availability of written protocols regarding invasive hemodynamic monitoring within ICUs was low (34.3%). The overall knowledge of critical care nurses (who participated in the study) about invasive hemodynamic monitoring was not acceptable. The results also showed that the estimated total practice of the registered nurses who participated in the study was either fair (75.6%) or poor (24.4%). This study indicated that critical care nurses' knowledge was poor to fair and that of registered nurses' practice was poor. The study showed unacceptable level of nurses' knowledge on hemodynamic monitoring. The nurses' practice about was poor [7].

CHAPTER THREE

MATERIAL

&METHEDOLOGY

MATERIALS AND METHODS

3-1. Study design:

This was descriptive hospital based study.

3-2. Study area:

Khartoum state is one of the eighteen states in Sudan. Although it is the smallest state by area, it is the most populous .it is contains the country's largest city by population, Omdurman, and the city of Khartoum, which is the capital of the state as well as the national capital of Sudan. The city is located in the heart of Sudan at the confluence of White Nile and Blue Nile, where the two rivers unites to form the river Nile. The state lies between longitudinal 31.5 to 34 E and 15 to 16 N .it is surrounded by river Nile state in the north-east , in the north – west by the northern state, in the east and southeast by state of kassala, gedaref and gezira, and in the west by northkurdufan.

3-3. Study setting:

The study was conducted at Khartoum City, Arkaweet locality, the study done at Sudan Heart Center the established at 2000 it provide diagnostic and treatment services to patients inside and outside Sudan. The north of it about 2Km is Alsalam Rotana Hotel, southern of it is new Sport City, Nor Alayoon Hospital is east of it, Africa Street and Future University from the west. The hospital contains many departments, cardiology medicine and cardiac surgery department, divided into, outpatient unit content (6) beds, Cath Lab unit content (9) beds, ICU content (7) beds, CCU content (8) beds, male ward (15) beds, female ward (15) beds, operation room(2), laboratory , and X- ray department.

3-4. Study population:

The study population includes registered nurses working of intensive care unit in Sudan Heart Center during the period of study.

3-4-1. Inclusion criteria:

The target groups of all registered nurses who worked in intensive care unit at Sudan Heart Center during the period of the study.Those who are agree to be included in this study (verbal consent).

3-5. Sample size:

Total coverage of (30) number of working staff in the hospital at intensive care unit during the period of study.

3-6. Data collection tools:

The data were collected using an interview questionnaire design for collecting data such as general characteristics of study sample as gender, education level ,experiences, and includes nurses' knowledge about invasive hemodynamic monitoring

3-7. Data processing and analysis:

The data were collected processed and transferred to computer coding.

the descriptive analysis was adopted which include percentage, frequently distribution inform of tables and figures illustration of frequently distribution was done using statistical package for social sciences.

Likert scal for knowledge was used for assessment(25):

poor, fair, good.If the response was less than 50% it consider as poor

If the response from 50 -75 consider as fair If the response from 76 -100 consider as good.

In the questions of Yes or No style the interpretation as the following if the response of yes:

- Less than 50% - poor
- 50 – 75 is fair
- 76 – 100 is good

3-8. Ethical consideration:

- Letter was obtained from the university.

- Approval from Sudan heart center training manager.

- The participants were oriented by the aim of the study.

- Verbal consent was obtained from participants.

- Confidentiality of the participants was considered.

- The name of the participants was not mention.

- The participants have a right to ask, discontinue and refuse to answer any question.

- The data was collected during the rest time.

CHAPTER FOUR

RESULT

4-1 Result

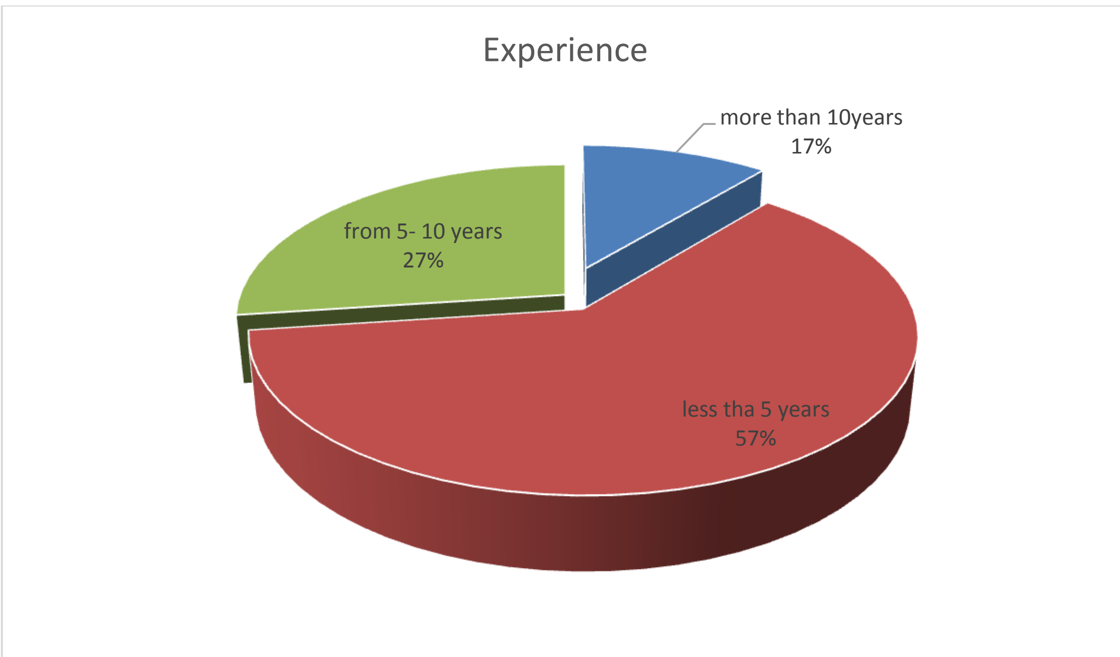
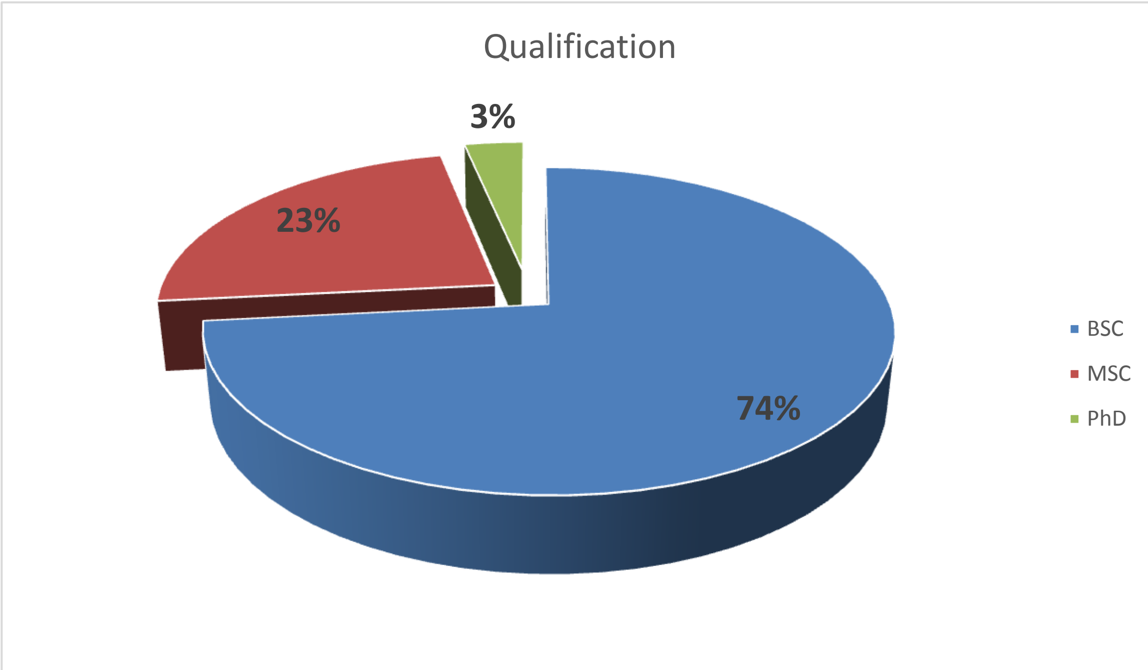


Figure (1): Show the distribution of study sample according to experience

Figure (2) show 56.7% of nurses are worked less than 5 year , 26.7 from 5-10 years and 16.7 more than 10 year



<u>Figure(2):Show the distribution of study sample according to qualification</u>

Figure(2) showed most of nurses (74%) have bachelor degree ,23% have master degree and 3% have PhD

Table (1) Distribution of study sample according to the gender

Gender		
	Frequency	Percent (%)
Male	15	50.0
Female	15	50.0
Total	30	100.0

Table (1) show that (50%) of the study sample were male and (50%) female

Table (2) : Distribution of study sample according to Attendance of hemodynamic course:

Attendance of hemodynamic course		
	Frequency	**Percent(%)**
YES	12	40.0
NO	18	60.0
Total	30	100.0

Table (2) show that most of nurses 60% didn't attend or receive courses in invasive hemodynamic monitoring and 40% were received.

Table (3): Distribution of study sample according to their knowledge about Devices used in hemodynamic monitoring:

Type of devices used in invasive hemodynamic monitoring		
	Frequency	**Percent(%)**
Poor	5	16
Fair	11	36.6
Good	14	46.6
Total	30	100.0

Table (3) show that just 16% from study sample have poor knowledge about devices used in invasive hemodynamic monitoring ,36.6% of nurses have fair knowledge and46.6% have good knowledg

Table(4):Distribution of the study sample according to their Knowledge regarding indications of invasive hemodynamic monitoring.

Indication for invasive hemodynamic monitoring		
	Frequency	Percent(%)
Poor	11	36.7
Fair	8	26.6
Good	11	36.7
Total	30	100.0

Table (4) indicate that(36.7%) responded with poor correct answer regarding indication of invasive hemodynamic monitoring, 26.6% responded with fair correct answer and 36.7% have good knowledge.

Table (5) Distribution of the study sample according to their knowledge regarding CVP is indicated to measure preload

Central venous pressure is indicated to measure preload		
	Frequency	Percent(%)
YES	22	73.3
NO	8	26.7
Total	30	100.0

Table(5) illustrate that most of the nurses (73.3%) said that the CVP is indicate to measure preload and 26.7% said no.

Table (6) Distribution of the study sample according to theirknowledge regarding arterial blood pressure is indicated to measure afterload

Arterial blood pressure is indicated to measure afterload		
	Frequency	**Percent(%)**
YES	22	73.3
NO	8	26.7
Total	30	100.0

Table (6) illustrate that most of the nurses (73.3%) said that the arterial blood pressure is indicate to measure after load and 26.7% said no.

Table no (7) Distribution of the study sample according to their knowledge about calibration of pressure system

Calibration of the system should be at least every shift		
	Frequency	**Percent(%)**
YES	26	86.7
NO	4	13.3
Total	30	100.0

Table(7) most of the nurses(86,7%) said the calibration of pressure system at least every shift and 13.3% said no.

Table no (8) distribution of the study sample according to their knowledge about pressure in pressure system

The pressure in the pressure bag should be 300 mmHg		
	Frequency	**Percent(%)**
YES	27	90.0
NO	3	10.0
Total	30	100.0

Table (8) show that 90% of nurses said the pressure in the pressure bag should be 300 mmHg and 10% said no.

Table no (9) distribution of the study sample according to their knowledge regarding pressure system

Pressure system making regular flush every one hour		
	Frequency	**Percent(%)**
YES	23	76.7
NO	7	23.3
Total	30	100.0

Table (9) show that most of the nurses (76,7) are knowledgeable about regular flush of pressure system and 23.3 said no.

Table (10) distribution of study sample according to their knowledge regarding insertion of arterial line

Preparation for Insertion of arterial line needs		
	Frequency	**Percent(%)**
Poor	5	16.7
Fair	5	16.7
Good	20	66.6
Total	30	100.0

Table (10) show that (16.7) of nurses were poor knowledge about preparation for insertion of arterial line, 16.7% have fair knowledge and 66.6% have good knowledge.

Table (11) Distribution of study sample according to their knowledge about indicationof arterial pressure monitoring

Indications of arterial pressure monitoring		
	Frequency	**Percent(%)**
Poor	8	26.7
fair	8	26.7
good	14	46.6
Total	30	100.0

Table (11) show that26.7% of nurses were poor knowledge about indication of arterial pressure monitoring, 26.7% were fair knowledge and 46.6% have good knowledge.

Table (12) Distribution of study sample according to their knowledge about complication of arterial catheter

Complication of arterial catheter		
	Frequency	Percent(%)
poor	8	26.7
Fair	9	30.
good	13	43.3
Total	30	100.0

Table (12) show that 26.7% of nurses have poor knowledge,30% have fair knowledge and 43.3% have good knowledge about complications of arterial catheter.

Table(13) Distribution of study sample according their knowledge regarding preparation for insertion of central line

Preparation for Insertion of central line needs		
	Frequency	Percent(%)
Poor	4	13.3
Fair	6	20
Good	20	66.7
Total	30	100.0

Table (13) show about (13.3%) of nurses have poor knowledge about preparation for insertion of central line, 20% have fair knowledgeand 66.7% have good knowledge.

Table (14) Distribution of study sample according to their knowledge about normal value of CVP

Normal value of CVP is 2-6 mmHg		
	Frequency	**Percent(%)**
YES	7	23.3
NO	23	76.7
Total	30	100.0

Table(14) show that most of nurses(76,7) didn't knowledge about normal value of CVP and 23.3 were knowledgeable.

Table (15) Distribution of study sample according to nursing action if CVP is high

Nursing action if CVP is high		
	Frequency	**Percent(%)**
Poor	6	20
Fair	6	20
Good	18	60
Total	30	100.0

Table(15) show about 20% of nurses have poor knowledge, 20% have fair knowledge and 60% have good knowledge.

Table (16) Distribution of study sample according to the knowledge about the most common complication of CVC

The most common complication of subclavian CVC is pneumothorax		
	Frequency	**Percent (%)**
YES	26	86.7
NO	4	13.3
Total	30	100.0

Table(16) show that most nurses(86.7%) are knowledgeable about the most common complication of CVC, 13.3% were not knowledgeable.

Table (17) Distribution of study sample according to knowledge about normal value of PAP

Normal value of systolic PAP is 20-30 mmHg		
	Frequency	**Percent(%)**
YES	16	53.3
NO	14	46.7
Total	30	100.0

Table(17) show that 53.3% of nurses are knowledgeable about normal value of systolic PAP

Table no (18) Distribution of study sample according to knowledge about indications of PAP monitoring

Indication of PAP monitoring		
	Frequency	**Percent(%)**
Poor	13	43.3
Fair	6	20
Good	11	36.7
Total	30	100.0

Table(18) show that 43.3% of nurses have poor knowledge about indications of PAP monitoring, 20% have fair knowledge and 36.7% have good knowledge.

Table no (19) Distribution of study sample according their knowledge about complication of PAC

Complication of PAC		
	Frequency	**Percent(%)**
Poor	8	26.7
Fair	4	13.3
Good	18	60
Total	30	100.0

Table (19) show that 26.7% of nurses have poor knowledge about complications of PAC, 13.3% have fair knowledge, and 60% have good knowledge.

Table (20) Distribution of study sample about nursing role in prevention of infection during invasive hemodynamic monitoring

Nursing role in prevention of infection during IHDM		
	Frequency	**Percent(%)**
Poor	2	6.7
Fair	4	13.3
Good	24	80
Total	30	100.0

Table (20) show that 6.7% of nurses have poor knowledge about nursing role in prevention of infection during invasive hemodynamic monitoring, 13.3% have fair knowledge, and 80% have good knowledge.

Table (21) Distribution of study sample according to their knowledge about patient needs during invasive hemodynamic monitoring

IHM's patient needs		
	Frequency	**Percent(%)**
Poor	6	20
Fair	6	20
Good	18	60
Total	30	100.0

Table (21) show that just 20% of nurses have poor knowledge about patient needs during invasive hemodynamic monitoring, 20% have fair knowledge and 60% have good knowledge.

Table (22) Distribution of study sample to know the barrier influence invasive hemodynamic monitoring.

Barrier affecting and influencing IHDM		
	Frequency	**Percent(%)**
lack of trained staff	15	50.0
lack of protocol	3	10.0
lack of knowledge	8	26.7
lack of motivation	3	10.0
lack of equipment	1	3.3
Total	30	100.0

Table (22) show that 50% of nurses said lack of trained staff is the barrier influence invasive hemodynamic monitoring.

Table no (23) Distribution of study sample according to their knowledge about nursing consideration during invasive hemodynamic monitoring

Nursing consideration during invasive hemodynamic monitoring		
	Frequency	**Percent (%)**
Poor	1	3.3
Fair	3	10
Good	26	86.7
Total	30	100.0

Table (23) indicate that 3.3% of nurses responded with poor knowledge about nursing consideration during IHDM,10% have fair, and 86.7% responded with good knowledge.

Table (24) Distribution of comparison between the Qualifications with the Indications of arterial pressure monitoring

Qualification	Indications of arterial pressure monitoring				p. value
	Poor	fair	good	Total	
BSC	6	5	11	22	0.007
MSC	2	3	2	7	
PhD	0	0	1	1	
Total	8	8	14	30	

Table (24) show that the effect of qualification in the knowledge about indications of arterial pressure monitoring is statistically significant because p. value is less than 0.05

Table (25) Correlation between the Qualification with the Complication of arterial catheter

Qualification	Complication of arterial catheter				p. value
	Poor	fair	good	Total	
BSC	5	9	8	22	0.000
MSC	3	0	4	7	
PhD	0	0	1	1	
Total	8	9	13	30	

Table (25) showed there is relationship between qualification and the nurses knowledge regarding complication of arterial catheter statistically significant because p. value is less than 0.05.

Table (26) Correlation between the Qualification with the preparation for Insertion of central line

Qualification	Preparation for Insertion of central line				p. value
	Poor	fair	Good	Total	
BSC	4	3	15	22	0.000
MSC	0	3	4	7	
PhD	0	0	1	1	
Total	3	4	16	30	

Table (26) show that there is significant effect of qualification to nurses knowledge regarding preparation for insertion of central line because p. value is less than 0.05

Table (27) Correlation between the Qualifications with the Indication of PAP monitoring

Qualification	Indication of PAP monitoring			Total	p. value
	Poor	fair	good		
BSC	9	6	7	22	0.060
MSC	4	0	3	7	
PhD	0	0	1	1	
Total	13	6	11	30	

Table (27) showed the effect of qualification on the nurses knowledge regarding indication of PAP monitoring werenot significant Because p. value is greater than 0.05.

Table (28) Correlation between the Qualificationwith the Nursing role in prevention of infection during invasive hemodynamic monitoring

Qualification	Nursing role in prevention of infection during invasive hemodynamic monitoring				p. value
	Poor	fair	Good	Total	
BSC	1	3	18	22	0.012
MSC	1	1	5	7	
PhD	0	0	1	1	
Total	2	4	24	30	

Table (28) study show the effect of qualification to the nursesknowledge regarding nursing role in prevention of infection during IHDM is significant Because p. value is less than 0.05.

Table (29) Correlation between the Qualifications with the Nursing consideration during invasive hemodynamic monitoring

Qualification	Nursing consideration during invasive hemodynamic monitoring				p. value
	poor	fair	good	Total	
BSC	1	1	20	22	0.000
MSC	0	2	5	7	
PhD	0	0	1	1	
Total	1	3	26	30	

Table (29) indicated that the relation between qualification and nurses knowledge about nursing consideration during IHDM is significant because p. value is less than 0.05

Table (30) Correlation between the Experience with the preparation for Insertion of central line

Experience	Preparation for Insertion of central line				
	Poor	Fair	good	Total	p. value
less than 5years	2	4	11	17	0.000
5-10 years	2	1	5	8	
more than 10 years	0	1	4	5	
Total	4	6	24	30	

Table (30) show the effect of experience to nurses knowledge regarding preparation for insertion of central line is significant because p. value is less Than 0.05

Table (31) Correlation between the Experience with the Indications of arterial pressure monitoring

Experience	Indications of arterial pressure monitoring				p. value
	poor	Fair	good	Total	
less than 5years	5	3	9	17	0.000
5-10 years	2	3	3	8	
more than 10 years	1	2	2	5	
Total	8	8	14	30	

Table (31) show the effect of experience to nurses knowledge regarding indication of arterial pressure monitoring is significant because p. value is less Than 0.05

Table (32) Correlationbetween the Experiences with the Indications of PAP monitoring

Experience	Indication of PAP monitoring				p. value
	poor	Fair	good	Total	
less than 5years	7	6	4	17	0.003
5-10 years	4	0	4	8	
more than 10 years	2	0	3	5	
Total	13	6	11	30	

Table (32) show the effect of experience to nurses knowledge regarding indication of PAP monitoring is significant because p. value is less Than 0.05

Table (33) Correlation between the Experiences with the Complication of PAC

Experience	Complication of PAC				p. value
	poor	Fair	Good	Total	
less than 5years	6	2	9	17	0.013
5-10 years	2	1	5	8	
more than 10 years	0	1	4	5	
Total	8	4	18	30	

Table (33) show the effect of experience to nurses knowledge regarding complication of PAC monitoring is significant because p. value is less Than 0.05

Table (34) Correlationbetween the Experience with the Nursing role in prevention of infection during IHDM

Experience	Nursing role in prevention of infection during IHM				p. value
	poor	Fair	good	Total	
less than 5years	1	3	13	17	0.010
5-10 years	1	1	6	8	
more than 10 years	0	0	5	5	
Total	2	4	26	30	

Table (34) show the effect of experience to nurses knowledge regarding nursing role in prevention of infection during IHDM is significant because p. value is Than 0.05

Table (35) Correlation between the Experiences with the Nursing consideration during invasive hemodynamic monitoring

Experience	Nursing consideration during invasive hemodynamic monitoring				p. value
	poor	Fair	Good	Total	
less than 5years	**1**	**1**	**15**	**17**	**0.000**
5-10 years	**0**	**1**	**7**	**8**	
more than 10 years	**0**	**1**	**4**	**5**	
Total	**1**	**3**	**26**	**30**	

Table (35) show the effect of experience to nurses knowledge regarding nursing consideration during IHDM is significant because p. value is less than 0.0

CHAPTER FIVE

DISCCUTION, CONCLUTION AND RECOMMENDATIONS

5.1 Discussion

Hemodynamic monitoring is one of the cornerstones of patient evaluation in the intensive care unit. Inaccurate measurement may create risk and mistakes in diagnosis as well as nursing and medical intervention.Invasive hemodynamic monitoring is one of the major competencies required for the critical care nurses,moreover, monitoring parameters and insurance of the accuracy of the invasive system are the crucial in providing high quality nursing care in the ICUs(5).

The study was conducted during the period of the study from march to September 2017 in Intensive Care Unit in Sudan Heart Center Khartoum State. Sudan. to assessing Nurse's Knowledge regarding invasive hemodynamic monitoring.

The study revealed that more than half of study sample are worked less than 5 years, majorty of them have bachelor dgree and most of them didn't recive course about invasive hemodynamic monitoring.

There is significant correlation between qualification and years of experience with nurses knowledge regarding IHDM this defer to study conducted on expert critical care nurses use of pulmonary artery pressure monitoring at Australia suggested not all nurses who practice in the field for lengthy period reach the level of an expert (23).

The study showed that less than half of study sample have good knowledge regarding devices used in IHDM, and about one third of nurses have good knowledge about indication of IHDM, just one third of staff have good knowledge about indication of PAP and indication of arterial pressure monitoring.

According to result of this study the knowledge about invasive hemodynamic monitoring was unacceptable similar to finding reported by study under taken by Ahmed W A in Khartoum governmental hospitals,cardiac intensive care unit. 2014 which showed unacceptable level of nurses knowledge in invasive hemodynamic monitoring [7].

regarding nurses knowledge in IHD pressure system as calibration, pressure in pressure bag, regular flush of the system most of them was good knowledge.

The study showed 50% of the nurses said lack of trained staff is the barrier facing staff performance during IHDM

5.2 Conclusion

According to the result of this study conducted that nurses knowledge regarding invasive hemodynamic monitoring were unaccepted specially in type of devices use in IHDM, indication of IHDM, indication of arterial pressure monitoring .

The effect of qualification and years of experiences are statistically significant on the level of nurses knowledge regarding IHDM because p. value less than 0.05.

5.2 Recommendation

The study recommended that

- Designing logbook about invasive hemodynamic monitoring and to be available for nurses in hospital.
- Periodic training program and courses about invasive hemodynamic monitoring with continuous supervision to assess the impact in performance.

APPENDEX

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بسم الله الرحمن الرحيم

Shendi University

PostgraduateCollage

Questioner about Nurses Knowledge Regarding Invasive Hemodynamic Monitoring In Cardiac Intensive Care Unit

Read questions carefully (more than on time), you have two types of questions: Yes / No questions

Put mark (√) if answer is Wright and (×) if answer is wrong.

1/gender:-

a) Male ( ) b) Female ( )

2/Experience:-

a) Less than 5 year. ( ) b) 5 -10years ( ) c) More than 10 years. ( )

3/Qualification:-

a) Diploma( ) b) B.S.C ( )

c) Master ( ) d) PHD ( )

4/Attendance of hemodynamic course:-

a) Yes ( ) b) No ( )

5/Devices used for invasive hemodynamic monitoring:-

a) Arterial line ( ) b) CVC ( )

c) Pulmonary artery catheter ( ) d) Transducer ( )

e) Pressure bag +extension tube ( )

6/Indication for invasive hemodynamic monitoring is:-

a) All shock state ( ) b) Loss of cardiac function ( )

c)Decrease cardiac output ( ) d)Cardiac surgery ( )

E) Refractory congestive heart failure ( )

7/Central venous pressure is indicated to measure preload:-

a)Yes ( ) b)No ( )

8/Arterial blood pressure is indicated to measure after load:-

a)Yes ( ) b)No( )

9/calibration of the system should be at least every shift.

a)Yes ( ) b)No ( )

10/The pressure in the pressure bag should be 300MMHg.

a)Yes ( ) b) No ( )

11/ Pressure system making regular flush every one hour.

a)Yes ( ) b) No ( )

12/preparation for Insertion of arterial line need:-

a)Explain procedure to the patient ( ) b)Chose the appropriate site of arterial canulation ( )

c)Make allens test ( )d)Monitoring system should be prepared ( )

e) Document the date and time of catheter insertion. ( )

13/ **Indication of arterial pressure monitoring is**

a) Monitor blood pressure ( ) b) Anticipation of hemodynamic instability ( )

c) Titration of vasoactive drugs ( ) d) Frequent blood sampling ( )

e) Morbid obesity ( )

14/Complication of arterial catheter

a)accidental blood loss ( ) b)impaired circulation ( )

c)infections ( ) d)psedo-aneurysm ( )

e) hematoma ( )

15/preparation for Insertion of central line need:-

a)Central venous catheter KIT. ( ) b) ECG should be monitored during the insertion ( )

c) Supine or trendelenburg position is required for patient( ) d)A septic technique ( )

e) Local anesthesia ( )

16/Normal value of CVP is 2-6 MMHg .

a)Yes ( ) b) No( )

17/If CVP is high you will:-

a)Check the devices ( ) b) Check CV line ( )

c) Position the patient ( ) d) Repotion transducer( ) e) Calibrate the system ( )

18/ The most common complication of subclavian central venous catheter (CVC) is pneumothorax?

a) Yes ( ) b) NO ( )

19/Normal value of systolic PAP is 20-30 mmHg

a) Yes ( ) b) No **( )**

20/ Indication of pulmonary artery pressure (PAP) monitoring is

a) Measures of pulmonary artery pressure ( ) b) Measure the right atrial pressure ( ) c) Taking mixed venous blood sampling ( ) d) Cardiac output measurement ( ) e) Calculate right ventricular ejection fraction **( )**

21/Complication of pulmonary artery catheter (PAC) is

a) Infection ( ) b) Thrombus ( )

c) Ventricular dysrhythmia ( ) d) Pulmonary artery rupture ( ) e) Pneumothorax ( )

22/ to prevent the infection occurrence in patient with IHDM you can

a)Check the site of line for signs of infection ( )

b)Dressing daily or if needed ( )

c) Change the flush device ,transeducer,flush solutions every 72 hours.( )

d)Keep lines clean and dry ( )

e) Keep the system tightiy close ( )

23/patient needs during invasive hemodynamic monitoring :-

a)Monitor for motion and movement ( ) b) Teaching about infection control ( )

c)Monitor temprature( ) d)Make Allen test( )

e) Close monitoring for parameter ( )

24/Barrier affecting invasive hemodynamic monitoring are:-

a)Lack of trained staf ( ) b)Lack of protocol ( )

c)Lack of knowledge ( ) d)Lack of motivation ( )

e) Lack of equipment ( ) f) Lack of devices ( )

g) Finance ( )

25/ Nursing consideration during invasive hemodynamic monitoring

a) Explain the procedure to the patient and his family ( )

b) Observe the pressure wave form to assess the arterial pressure, CVP and PAP ( )

c) To assess the insertion site for signs of infections ( )

d) Document the date and time of catheter insertion ( )

e) Maintain 300 mmHg pressure in pressure bag to allow 3 to 6 ml/hrs ( )