Original Article

ANATOLIAN CURRENT MEDICAL

DOI: 10.38053/acmj.826454

Anatolian Curr Med J 2021; 3(2); 85-92

Surgical nurses' knowledge levels about hemodynamic monitoring

Esra Özkan[1], Nurşen Kulakaç[2], Ceyda Uzun Şahin[3], Dilek Çilingir[4]

[1]Giresun University, Department of Vocational School of Health Services, Giresun, Turkey
[2]Gümüşhane University, Department of Vocational School of Health Services, Gümüşhane, Turkey
[3]Recep Tayyip Erdogan University, Department of Vocational School of Health Services, Rize, Turkey
[4]Karadeniz Technical University, Health Sciences Faculty, Nursing Department, Trabzon, Turkey

Cite this article as: Özkan E, Kulakaç N, Uzun Şahin C, Çilingir D. Surgical nurses' knowledge levels about hemodynamic monitoring. Anatolian Curr Med J 2021; 3(2); 85-92.

ABSTRACT

Aim: This study was carried out to determine surgical nurses' knowledge levels about hemodynamic monitoring.

Material and Method: The research was carried out in a descriptive design to determine the knowledge levels of surgical nurses related to hemodynamic monitoring. Nurses working in the surgical clinics of three hospitals in the Eastern Black Sea Region. 156 surgery nurses took part in the study. The data were collected through a questionnaire developed by the researchers. Percentage, mean, standard deviation, median, Kolmogorov-Smirnov test, t-test in independent groups, and variance analysis in multiple groups were used to evaluate the data in the research.

Results: The mean score of the nurses' knowledge about hemodynamic monitoring was 65.3±7.9. There was a significant difference between nurses' receiving education on monitoring, gender, marital status, education level and the mean scores of their knowledge about hemodynamic monitoring ($p<0.05$).

Conclusion: The study revealed that nurses had a lack of knowledge about hemodynamic monitoring, which was reflected in nursing care and practices. It is recommended that surgical nurses are provided detailed and regular training on hemodynamic monitoring methods and follow-up including nursing care.

Keywords: Surgical nurse, hemodynamic monitoring, invasive, non-invasive

INTRODUCTION

The term "hemodynamic" is defined as the branch of science that deals with blood circulation and the physical factors affecting it while monitoring refers to watching or following. In the field of health care, this concept indicates monitoring or following the vital functions of a patient (1,2).

The main purpose of monitoring including invasive and non-invasive methods is to advance the diagnosis, follow-up, and treatment. In this way, many subjective and numerical data such as vital signs, urinary flow, mechanical ventilation, blood gases, hematological and biochemical parameters, coagulation, intake and output follow-up, and physical examination findings can be monitored (3).

Hemodynamic monitoring is an important clinical decision that may be an indication for the intensive care admittance of high-risk surgical patients. It covers a wide range of procedures including monitoring of blood volume and blood circulation by placing an invasive catheter into the patient's vascular system, monitoring of hourly urine output, electrocardiography (ECG), laboratory examinations such as arterial blood gas monitoring, and hematocrit monitoring. Therefore, it provides a significant contribution to healthcare professionals to interpret patient outcomes and to ensure the necessary medical treatment and care (4,5).

Postoperative problems are important for surgical patients. Systematic application of hemodynamic monitoring before and after surgery will contribute positively to correct nursing interventions and will also facilitate the reduction of patient-specific problems (6). In maintaining nursing care after surgery, effective use of hemodynamic monitoring, when necessary, will help prevent complications in the cardiovascular system, respiratory system, fluid-electrolyte balance,

Corresponding Author: Ceyda Uzun Şahin, ceydam61@gmail.com

Received: 16.11.2020 **Accepted:** 22.01.2021

and adequate renal perfusion that may develop in the patient. The ability of the nurse to apply and interpret hemodynamic monitoring skills correctly and effectively enables the care to be guided and helps make an effective decision about the health status of a patient (7).

Although there are studies on hemodynamic monitoring in the literature, fewer studies have been conducted with surgical nurses on the subject. For this reason, the study is thought to contribute to the knowledge, attitude, and practices of the surgical nurses related to hemodynamic monitoring.

MATERIAL AND METHOD

Type of the Study

The research was carried out in a descriptive design to determine the knowledge levels of surgical nurses related to hemodynamic monitoring.

The Universe and the Sample of the Research

The data were collected between 1 and 30 June 2019. The universe of the research consisted of all the nurses working in the surgical clinics of one public hospital and two research and training hospitals in the Eastern Black Sea Region. It was aimed to reach the entire universe without using a sampling method; however, twelve nurses who were not in the hospital (on sick leave, on leave) or refused to participate in the study were not included in the study, so the study was completed with 156 nurses who agreed to take part in the research and completed the data collection form.

Data Collection Tools and Data Collection

The data were collected by a questionnaire that prepared by the researchers the literature rewiev (9,10). The form consists of three sections and 48 questions. In the first section, there are six questions about the descriptive characteristics of nurses. The second section includes 26 questions about non-invasive monitoring, and the third section contains 16 questions about invasive monitoring. The questions regarding monitoring are responded as "right", "wrong" and "I don't know" and are evaluated as 2, 1, and 0 points respectively. The lowest and highest scores to be obtained from the information form on non-invasive hemodynamic monitoring and invasive hemodynamic monitoring are 0-52 and 0-32 respectively. Cronbach Alpha reliability coefficient of the questions was found 0.71. In evaluating the content validity of the prepared questions, expert opinions were received from the academic staff in the field of nursing. Necessary changes were made in the data collection form in line with the suggestions of the experts. After informing the surgical nurses about the purpose and duration of the research, the data were collected from the voluntary nurses through the face-to-face interview method. It took 10-15 minutes to complete the questionnaire.

Evaluation of the Data

SPSS 22.0 statistical package program was used for statistical analysis in the study. In the evaluation of the data, descriptive statistical methods such as percentage, mean, standard deviation, median, and Kolmogorov-Smirnov distribution test were used for the normal distribution. For the two-group comparison of quantitative variables, independent group t-test, and for the multiple groups, variance analysis was used. Statistical significance was accepted at the level of $p<0.05$.

Ethical Aspect of the Research

To conduct the study, permission numbered 05/2019 was obtained by the Scientific Research and Publication Ethics Committee of Gümüşhane University. Informed consent was received from the nurses in line with the principle of volunteering. The study was carried out in compliance with the ethical standards stated in the Helsinki Declaration.

RESULTS

The study showed that the mean age of the nurses was 32.1±1.2 (min=19, max=49), 76.3% were women. 54.5% were married, 66% were undergraduate graduates, the average working experience was 10.7±7.7 years, and 56.7% of the nurses received training on hemodynamic monitoring (**Table 1**).

Table 1. Descriptive characteristics of nurses (n = 156)

Descriptive characteristics	n	%
Gender		
Female	119	76.3
Male	37	23.7
Education level		
High school	16	10.3
Associate degree	37	23.7
Undergraduate degree	103	66.0
Marital status		
Married	85	54.5
Single	71	45.5
Status of receiving education about hemodynamic monitoring		
Yes	67	42.7
No	89	56.7
Working experience	10.9 ±7.7	
Age (year)	32.1±1.2	

The mean score of the nurses for non-invasive hemodynamic monitoring was found to be 43.7±4.6 (min=29, max=59). The nurses' knowledge level was determined to be high regarding the following items; ECG helps diagnose coronary insufficiency or myocardial infarction (97.4%), the patient's name, surname, date

and time must be written on the electrocardiogram obtained from ECG (97.4%), and monitoring is done to see the patient's response to treatment (96.2%). The number of correct answers given by nurses to the items of 'ECG provides information about the thickening of the heart muscle and enlargement of the heart cavities (%49.4), monitoring is done to determine the patient's organ reserves (48.1%), and ECG can be done in sitting position (34.6%)' were determined to be lower (**Table 2)**.

It was determined that the mean score of the nurses regarding invasive hemodynamic monitoring was 23.4±5.0 (min=9, max=41). Nurses had a high knowledge level regarding the questions such as 'Among the contraindications of the invasive arterial catheterization of nurses, regional infection, coagulation disorder and vasculature may develop (89.7%), sterile processing is not required for bladder catheterization, there is no need for a sterile procedure in bladder catheterization (84.6%), invasive catheterization is the most suitable method for blood pressure measurement of patients with unstable hemodynamics (82.7%), and the most effective way of urine monitoring is bladder catheterization (82.7%). However, the correct response rate of nurses to the following questions was found lower; in the catheter care used for central venous pressure, intravenous (IV) solution set buffers should be changed daily, and catheter entry dressing should be changed every 48-72 hours (67.9%), during central venous catheterization, air embolism and clot development should be monitored and in this case, the catheter should be washed with isotonic fluid (67.9%) and a separate urine bag must be used for each patient (66.7%) (**Table 3**).

Table 2. Responses and mean knowledge scores of the nurses to the questions regarding non-invasive hemodynamic monitoring (n=156)

Questions about non-invasive hemodynamic monitoring	Correct n %	Wrong n %	Don't know n %
1. Monitoring is done to collect data from the patient.	148 (94.9)	8 (5.1)	-
2. Monitoring is done to diagnose the patient.	88 (56.4)	64 (41.0)	4 (2.6)
3. Monitoring is done to determine the patient's organ reserves.	66 (42.3)	75 (48.1)	15 (9.6)
4. Monitoring is done to see the patient's response to treatment.	150 (96.2)	6 (3.8)	-
5. Monitoring is performed for the early identification of problems.	147 (94.2)	7 (4.5	2 (1.3)
6. ECG shows how the heart muscle contracts.	116 (74.4)	33 (21.2)	7 (4.5)
7. ECG gives information about the rhythm and conduction disorders of the heart.	147 (94.2)	9 (5.8)	-
8. ECG helps diagnose coronary insufficiency or myocardial infarction.	152 (97.4)	3 (1.9)	1 (0.6)
9. ECG provides information about the thickening of the heart muscle and enlargement of the heart cavities.	57 (36.5)	77 (49.4)	22 (14.1)
10. ECG gives information about the functions of an electronic pacemaker.	127 (81.4)	14 (9.0)	15 (9.6)
11. ECG gives information about the effects of some heart medications and electrolyte imbalance.	127 (81.4)	20 (12.8)	9 (5.8)
12. ECG gives information about the effects of non-cardiac diseases on the heart.	80 (51.3)	46 (29.5)	30 (19.2)
13. ECG can be done in sitting position.	94 (60.3)	54 (34.6)	8 (5.1)
14. Electrodes should not be located on diaphoretic skin.	146 (93.6)	10 (6.4)	-
15. Metal objects on the patient do not need to be removed.	104 (66.7)	52 (33.3)	-
16. A thin layer of electrode gel should be applied to the body surface where the electrode will be located.	143 (91.6)	13 (8.3)	-
17. ECG devices should be calibrated.	142 (91.0)	10 (6.4)	4 (2.6)
18. After the ECG device is switched off, the chest electrodes and then the limb electrodes must be removed.	98 (62.8)	27 (17.3)	31 (19.9)
19. The patient's name, surname, date, and time must be written on the electrocardiogram obtained from ECG.	152 (97.4)	3 (1.9)	1 (0.6)
20. Non-invasive arterial blood pressure is a quantitative measurement used to determine cardiovascular status.	133 (85.3)	12 (7.7)	11 (7.1)
21. Mismatches between the size of the cuff used to measure blood pressure and patient arm circumference affect the results.	146 (93.6)	9 (5.8)	1 (0.6)
22. Non-invasive arterial blood pressure is not a reliable method in critically ill patients with a poor general condition.	96 (61.5)	46 (29.5)	149.0
23. A pulse oximeter gives information about arterial oxygen value.	100 (64.1)	51 (32.7)	5 (3.2)
24. The pulse oximeter has limited reliability if there is a nutritional deficiency in the area measured in severe hypoxia.	138 (88.5)	15 (9.6)	3 (1.9)
25. With the capnograph, the level of carbon dioxide (CO2) in expiratory air can be measured by the non-invasive method.	95 (60.9)	15 (9.6)	46 (29.5)
26. Capnograph can evaluate the effectiveness of mechanical ventilation support.	102 (65.4)	3 (1.9)	51 (32.7)

It was found that the total mean score of the nurses regarding hemodynamic monitoring was 65.3±7.9 (min=39, max=82). The total knowledge scores of hemodynamic monitoring were significantly higher in male nurses and high school graduate nurses (p<0.05). Compared to married nurses, the knowledge scores of single nurses regarding invasive hemodynamic monitoring were also significantly higher. Besides, nurses who received education on hemodynamic monitoring were found to have significantly higher knowledge scores on non-invasive hemodynamic monitoring than those who did not (p<0.05) (**Table 4**).

Table 3. Responses of the nurses to the questions regarding invasive hemodynamic monitoring and the mean scores of their knowledge (n=156)

Questions on invasive hemodynamic monitoring	Correct n %	Wrong n %	Don't know n %
1. Invasive catheterization is the most suitable method for blood pressure measurement of patients with unstable hemodynamics.	129 (82.7)	15 (9.6)	12 (7.7)
2. The first method to be preferred for blood pressure measurement in a stable patient is invasive arterial monitoring.	102 (65.4)	50 (32.1)	4 (2.6)
3. The nurse is not at the forefront to follow the invasive arterial catheterization procedure.	100 (64.1)	43 (27.6)	13 (8.3)
4. It is the responsibility of the nurse to implement the invasive arterial catheterization procedure.	112 (71.8)	36 (23.1)	8 (5.1)t
5. It is the responsibility of the nurse to monitor the invasive arterial catheterization.	127 (81.4)	18 (11.5)	11 (7.1)
6. Contraindications for invasive arterial catheterization may include regional infection, coagulation disorder, and vasculitis.	140 (89.7)	6 (3.8)	10 (6.4)
7. Central venous pressure measures blood pressure in the thoracic vein at the end of the right atrium of the heart.	112 (71.8)	11 (7.1)	33 (21.2)
8. The central venous pressure normal value range is 8-12 mmHg.	100 (64.1)	27 (17.3)	29 (18.6)
9. The patient does not have to lie completely on the back during central venous pressure measurement.	87 (55.8)	48 (30.8)	21 (13.4)
10. In the catheter care used for central venous pressure, IV solution set buffers should be changed daily, and catheter entry dressing should be changed every 48-72 hours.	33 (21.2)	106 (67.9)	17 (10.9)
11. During central venous catheterization, air embolism and clot development should be monitored, and in this case, the catheter should be washed with isotonic fluid.	35 (22.4)	106 (67.9)	15 (9.6)
12. The most effective way of urine monitoring is bladder catheterization.	129 (82.7)	7 (4.5)	20 (12.8)
13. Sterile processing is not required for bladder catheterization.	132 (84.6)	21 (13.5)	3 (1.9)
14. Urine catheter should be regularly changed once a week.	101 (64.7)	44 (28.2)	11 (7.1)
15. A separate urine bag must be used for each patient.	45 (28.8)	104 (66.7)	7 (4.5)
16. Catheter and urine bags should be kept at the bladder level.	116 (74.4)	34 (21.8)	6 (3.8)

Table 4. Comparison of the knowledge mean scores of hemodynamic monitoring according to the descriptive characteristics of nurses (n=156)

	Knowledge mean scores		
Descriptive characteristics	**Non-invasive monitoring Mean±SD**	**Invasive monitoring Mean±SD**	**Total Mean±SD**
Gender			
Female	43.16±4.34	22.90±5.33	64.21±7.72
Male	45.56±4.98	25.27±3.34	69.08±7.45
	t=-2.83	t=-2.54	t=-3.37
	p=0.005	p=0.012	p=0.001
Education level			
High school	47.06±6.02	27.25±3.99	71.25±8.69
Associate degree	43.21±3.63	24.27±5.49	65.78±7.67
Undergraduate degree	43.40±4.49	22.59±4.70	64.31±7.51
	F=4.912	F=7.081	F=5.717
	p=0.009	p=0.001	p=0.004
Marital status			
Single	44.33±5.43	24.42±4.97	66.74±8.61
Married	43.23±3.73	22.67±4.95	64.22±7.12
	t=1.49	t=2.19	t=2.00
	p=0.137	p=0.030	p=0.047
The status of receiving education regarding hemodynamic monitoring			
Yes	44.86±8.6	23.22±5.41	64.41±6.68
No	44.39±5.17	23.65±4.73	66.08±8.69
	t=-2.073	t=-0.525	t=-1.30
	p=0.040	p=0.600	p=0.192

DISCUSSION

This research was conducted in a descriptive design to determine the knowledge levels of surgical nurses regarding hemodynamic monitoring. In this section, the results of the research are discussed with the literature findings.

Monitoring refers to the process of measuring and recording physiological parameters by use a modern catheter and electronic catheterization devices. The basic principle is the conversion of biophysical events in certain parts of the body into electrical signals, making them visible, measurable, and even recorded as a graphic. Clinical monitoring, starting with simple systemic blood pressure monitoring, varies considerably with hardware support in the development of permanent catheters and ensuring the accuracy of the data during the cardiovascular evaluation process (1,10). The term hemodynamics is defined as the branch of science that deals with blood circulation and the influencing physical factors, and monitoring is a technology that is used frequently in critical care, allowing rapid assessment and intervention, and continuous monitoring of the patient's general condition (11).

To ensure the hemodynamic stability of the patient, monitoring techniques and correct follow-up of patients are among the important issues that must be known by healthcare professionals (12). Conducted a study in an intensive care unit and noted that 43.3% of the nurses were in the 26-30 age group, 49.4% were associate degree graduates, and 38.9% had 0-5 years of working experience (13). In a study involving nurses working in the emergency and intensive care unit, it was stated that 64.6% of the nurses were between 23 and 32 years old, 52.1% of them were undergraduate graduates, and 50% had 0-4 years of working experience (14). In our study, the mean age of nurses was 32.1±1.2, 54.5% were married, 66% were undergraduate graduates, and the average working experience was 10.7±7.7 years. When our study was compared with the literature, there were some differences in the results obtained. It is thought that the differences depending on the mean age and working experience may be due to the employment of nurses in the emergency and intensive care unit in the first years of the profession, and the differences in the level of education are due to an increase in the number of undergraduates over the years.

The monitoring techniques that applied without disrupting the skin integrity and entering the vascular structures are called non-invasive methods. Electrocardiogram (ECG), non-invasive blood pressure, body temperature, respiratory rate, pulse oxymeter (SPO2), end-tidal carbon dioxide (EtCO2) are among the non-invasive techniques used in patient follow-up (15).

Due to coronary artery diseases that are likely to be encountered today, ECG monitoring and evaluation should be performed in most services, nurses working in all units should be able to recognize ECG findings in emergency heart diseases and evaluate appropriate treatment approaches. Doğan et al. (16) (2012) found that 80% of the nurses incorrectly determined the location of the chest derivations in the electrocardiography monitoring. In our study, 36.5% of the nurses gave the correct answer in response to the item of ECG provides information about the thickening of the heart muscle and enlargement of the heart cavities, 14% did not know the relationship between them and 34.6% stated that ECG can be done in sitting position. Another study reported that the majority of the nurses working in intensive care units and emergency departments did not receive training on ECG and ECG evaluations and interventions of trained nurses were not sufficient, but the same study also argued that the ECG/monitor should only be evaluated by the physician (17). Çelik et al. (14) stated that 58.3% of nurses did not participate in the in-service training. In the study conducted by Doğu et al. (18) it was emphasized that nurses working in clinics where monitoring was followed and cardiac rhythm problems were frequently encountered had insufficient information about ECG findings and interventions. Similar to the literature, in this study, nurses also had a lack of information in the questions regarding the ECG's determination of cardiac problems and the correct method of monitoring.

Organ perfusion is expressed as a sufficient blood flow that is required for the delivery of oxygen and substrates and for the excretion of metabolic waste with the formation of a high perfusion pressure in all organs and cells. Therefore, to provide tissue perfusion, maintaining body organ perfusion in intensive care conditions and perioperative care is a common goal (17). Among the methods used for the protection of organ perfusion, the priority is blood pressure measurement (19). Measuring the blood pressure is the most important diagnostic method used in the diagnosis of hypertension and hypotension. It is stated that the way to avoid misdiagnosis and improper treatment is to measure the blood pressure correctly (20). In a study, it was determined that the majority of nurses received information about the use of medical devices from other healthcare workers (17). In our study, it was determined that 42% of the nurses gave the correct answer to the question asked about the function of monitoring in the determination of the patient's organ reserves. Additionally, a lack of information about the materials used in the monitoring and the effect of the monitoring on the organ reserves was observed in nurses, and this situation is thought to affect the correct follow-up and care quality.

Current resuscitation guidelines suggest waveform capnography as an indication of indirect perfusion during cardiopulmonary resuscitation (CPR). ETCO2 is the partial carbon dioxide pressure at the end of expiratory and measured by a capnograph device. Parameters provided by respiratory gas monitoring, such as respiratory gas flow, are required to monitor the saturation level of the patient (21,22). In a study that retrospectively investigated the differences in arterial-end-tidal carbon dioxide in 799 pediatric patients undergoing general anesthesia with ventilation, it was determined that the decrease in PaCO2 was strongly related to the decrease in the PaCO2-ETCO2 difference (23). 29.5% and 32.7% of the nurses were found to have no knowledge about the function of the capnograph device and its effectiveness during the mechanical ventilator respectively. This situation suggests that nurses had a lack of knowledge of the evaluation of blood gas and follow-up for the respiratory system. As the result of the study, nurses' mean knowledge score for non-invasive hemodynamic monitoring was high, but there was a lack of knowledge in theory and practice.

Thanks to the cannula placed in an artery in the measurement of invasive arterial blood pressure, quick and instant information about arterial blood pressure are obtained. It is stated in the American Heart Society Guideline that inappropriate cuff sizes can cause serious deviations in blood pressure and result in inappropriate treatments. Although invasive monitoring is accepted as the reference method, non-invasive monitoring is advantageous due to fewer complications in terms of accuracy, precision, and rapid response change, so in critical situations, invasive methods should be preferred in patients (15,24,25). Similar to the literature, in our study, 82.7% of the nurses stated that invasive arterial blood pressure measurement is a reliable method in critically ill patients with a poor general condition. It was seen that there was a significant difference between the education level of the nurses and the knowledge scores of invasive monitoring and that there was no significant difference between the knowledge scores of invasive monitoring for the nurses who were trained for monitoring techniques and who were not.

In the infections developed due to catheters, the length of hospital stay of the patient is extended by an average of seven days, and the cost increase is reported to be 34.508-56.000 dollars (26). The UK National Institute for Health and Care Excellence (NICE) developed guidelines for the infection prevention and control in 2014, and according to this guideline the permanent catheter should be connected to the sterile urine drainage system and should not be separated from the closed drainage system unless necessary, and additionally, a separate drain pan should be used for each patient (27,28). In a study, it was pointed out that there is a 3-8% incidence of bacteriuria per day after bladder catheterization in hospitals (29). In another study, it was found that intensive care nurses had insufficient knowledge about the use of urine bags, changing urine bags, and using a separate drain pan for each patient (28). In the study of Köse et al. (30) found 26.4% of the nurses replied the question about replacing the bladder every week as 'correct', and 14.1% replied as 'I don't know'. In our study, the knowledge level of nurses was found high about the most effective way of urine monitoring which is bladder catheterization (82.7%), however, 64.7% expressed that the urinary catheter should be regularly changed once a week. Similar to the literature, in our study, nurses had a lack of knowledge related to bladder catheterization and care. It is thought that this situation may affect the development of an infection as a result of ongoing wrong practices due to a lack of information. It is thought nurses do not follow in-service training and evidence-based practices.

Central venous catheters (CVC) are used for different indications in hospitalized patients. Especially long term central venous catheters have an important place in the support treatment of cancer patients. It is a process of inserting a catheter with various features into a vein directly going to the heart. Although they have many benefits, their widespread use in recent years has also increased the incidence of some complications. The two most common major complications are indicated as infection and thrombosis, so it is recommended in the literature that attention should be paid not to contaminate the catheter inlet area during sponge change (31-34). In an observational study, it was seen that the nurses either did not clean or do the wrong application of hand hygiene, three-way tap cleaning with a disinfectant containing alcohol, treatment after drying of alcohol and washing the lumen after treatment (35). In our study, the item regarding the possibility of CVC infection is 'In the catheter care used for central venous pressure, IV solution set buffers should be changed daily and catheter entry dressing should be changed every 48-72 hours' and 67.9% of the nurses replied it as 'wrong', and 17.9% of them replied as 'I don't know'. Besides, 67.9% of the nurses gave the wrong answer to the item of 'During central venous catheterization, air embolism and clot development should be monitored and in this case, the catheter should be washed with isotonic fluid'. Similar to the literature, the nurses in our study had a lack of knowledge on CVC care and its possible complications.

CONCLUSION

The review of available literature revealed that the studies measuring the knowledge levels of nurses about hemodynamic monitoring have been infrequently conducted. Therefore, we think that our study is one of the unique studies performed to measure the knowledge level of surgical nurses on hemodynamic monitoring. It is thought to help fill the gap in the related literature. Hemodynamic monitoring is a guideline used to provide cell, tissue, and organ perfusion. Nurses, the practitioners of these guides, should have the correct information to ensure patient follow-up. As a result of the research, it was concluded that the nurses had a lack of knowledge about hemodynamic monitoring, the purpose of ECG and capnography, non-invasive hemodynamic monitoring, indication, central venous catheter care and its complications, urinary catheterization, and nursing care. In line with these results, it is recommended to give nurses working in surgical and intensive care clinics detailed and regular training on hemodynamic monitoring methods, nursing follow-up and care, and to evaluate the reflection of training on practice.

ETHICAL DECLARATIONS

Ethics Committee Approval: To conduct the study, permission numbered 05/2019 was obtained by the Scientific Resaerch and Publications Ethics Committee of Gümüşhane University.

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Cosar A, Eskin B. Yanik hastalarinda hemodinamik monitorizasyon. J Turk Soc Intens Care 2011; 9: 11-20.
2. Turner MA. Doppler-based hemodynamic monitoring. AACN Clin Issues 2003; 14: 220-31.
3. Kesici S, Bayrakçı B. Yoğun bakımda monitorizasyonda yenilikler. Turkiye Klinikleri J Pediatr 2011; 7: 43-8.
4. Akıncı SB. Kritik hastada hemodinamik monitörizasyon. J Turk Soc Intens Care 2003; 3: 5-21.
5. Lough ME. Introduction to hemodynamic monitoring. Nurs Clin North Am 1987; 22: 89-110.
6. Büyükyılmaz F, Şendir M. Cerrahi hastalarında barsak boşaltımı sorunlarına yönelik hemşirelik bakımı. Maltepe Üniversitesi Hemşirelik Bilim ve Sanatı Derg 2009; 2: 74-81.
7. Erdil F, Özhan-Elbaş N. Cerrahi hastalıkları hemşireliği. Ankara: Aydoğdu Ofset; 2001. s.456-505.
8. Çelik S. Erişkin yoğun bakım hastalarında temel sorunlar ve hemşirelik bakımı. Ankara: Nobel Tıp; 2014.
9. Karadakovan A, Eti Aslan F. Dahili ve cerrahi hastalıklarda bakım. Ankara: Akademisyen Tıp Kitabevi; 2013. s.201-307
10. Murray JM, Joursan DB, Pearl RG, Prough DS. Critical care medicine perioperative management. Philadelphia: Lippincott Williams & Wilkins, 2002; 11-12.
11. Dietz B, Smith TT. Enhancing the accuracy of hemodynamic monitoring. J Nurs Care 2002; 17: 27-34.
12. Göz F, Baran G. Hemşirelerin elektrokardiyografiye (EKG) ilişkin değerlendirmelerinin ve eğitim gereksinimlerinin belirlenmesi. C.Ü. Hemşirelik Yüksekokulu Derg 2000; 4: 33-9.
13. Çelen Ö, Karaalp T, Kaya S, Demir C, Teke A, Akdeniz A. Gülhane askeri tıp fakültesi eğitim hastanesi yoğun bakım ünitelerinde görev yapan hemşirelerine uygulanan hizmet içi eğitim programlarından beklentileri ve bu programlar ile ilgili düşünceleri. Gülhane Tıp Derg 2007; 49: 25-31
14. Çelik Y, Karadaş C, Akdağ C, Özkeçeci G. Acil ve yoğun bakım servislerinde çalışan hemşirelerin EKG bilgi düzeylerinin değerlendirilmesi. Türk Kardiyol Dern Kardiyovasküler Hemşirelik Derg 2015; 6: 75-85
15. Eti Aslan F, Olgun N. Yoğun bakımda seçilmiş semptom ve bulguların yönetimi. Ankara Akademisyen Kitabevi, 2016; 16-18.
16. Doğan HD, Melek M. Hemşirelerin acil kalp hastalıklarında görülen, EKG bulgularını tanıyabilme ve uygun tedavi yaklaşımlarını değerlendirebilme düzeylerinin tespiti. Türk Kardiyol Dern Kardiyovasküler Hemşirelik Derg 2012; 1-10
17. Cholley BP, Payen D. Noninvasive techniques for measurements of cardiac output. Curr Opin Crit Care 2005; 11: 424-9.
18. Doğu E, Gündüz H, Dede E. Kardiyoloji, yoğun bakım ve acil biriminde çalışan hemşirelerin EKG bulgularını tanıyabilme ve uygun tedavi girişimlerinde bulunabilme durumlarının değerlendirilmesi. Sakaryamj 2014; 4: 178-81.
19. Altıntaş DN, İskit Topeli A. Vazoaktif ve inotropik ilaçların doğru kullanımı. Yoğun Bakım Derg 2006; 6: 179-90
20. Şahin TK, Demir LS, Koruk İ. Bir tip fakültesi hastanesi'nde görevli hemşirelerin kan basinci ölçüm bilgilerinin değerlendirilmesi. Tsk Koruyucu Hekimlik Bülteni, 2006: 5.
21. Gutiérrez JJ, Ruiz JM, Gauna SR, et al. Modeling the impact of ventilations on the capnogram in out-of-hospital cardiac arrest. PLoS One. 2020; 1-15
22. Yang J, Chen B, Burk K, Wang Haitao, Zhou J. A mainstream monitoring system for respiratory CO2 Concentration and Gasflow. J Clin Moni Comput 2016; 30: 467-73.
23. Onodi C, Bühler PK, Thomas J, Schmitz A, Weiss M. Arterial to end-tidal carbon dioxide difference in children undergoing mechanical ventilation of the lungs during general anesthesia. Anesthesia. 2017; 72: 1357-64.
24. Nguyen LS, Squara P. Non-invasive monitoring of cardiac output in critical care medicine. Front Med (Lausanne) 2017; 4: 200.
25. Yıldız H. Yoğun bakımda hipertansiyon. Yoğun Bakım Hemşireliği Derg 2014; 18: 62-7.
26. Keskin S, Saba R, İnan D, Yılmaz M, Öngüt G, Günay V, Namıkoğlu L. Yoğun bakım hastalarında santral venöz kateterle ilişkili infeksiyonlar. Yoğun Bakım Derg 2004; 4: 190-4.

27. Thomas K. Use of Catheter Maintenance Solutions by Community Nursing Staff: An Assessment. Br J Community Nurs 2010; 25: 65-9.

28. Çelik S, Karaman D, Yanık F, veren F. Yoğun bakım hemşirelerinin kateter ile ilişkili üriner sistem enfeksiyonlarının önlenmesi hakkındaki bilgi durumları. Acıbadem Üniversitesi Sağlık Bilimleri Derg 2011; 2: 215-20.

29. Kranz J, Schmidt S, Wagenlehner F, Schneidewind L. Catheter-associated urinary tract infections in adult patients. Dtsch Arztebl Int 2020; 117: 83-8.

30. Köse Y, Leblebici Y, Akdere Şen S, et al. Bir kamu hastanesinde çalışan hemşirelerin kateter ilişkili üriner sistem enfeksiyonlarının önlenmesi hakkındaki bilgi durumları. Şişli Etfal Hastanesi Tıp Bülteni. 2016; 50: 70-9.

31. Yeşil Ş, Tanyıldız HG, Ardıçlı B, et al. Santral venöz kateter komplikasyonları. GMJ 2014; 25: 135-7

32. Theaker C. Infection control issues in central venous catheter care. Intensive Crit Care Nurs 2005; 21: 99-109.

33. Kuter DJ. Thrombotic complications of central venous catheters in cancer patients. Oncologist 2004; 9: 207-16.

34. Ovayolu N, Güner Çoşkun İ, Karadağ G. Santral venöz kateter (SVK) uygulanan hastalarda uygulama öncesi ve sonrası alınan önlemlerin belirlenmesi. Atatürk Üniversitesi Hemşirelik Yüksekokulu Derg 2006; 9: 26-35

35. Gürol Arslan G, Özden D, Alan N, Yilmaz İ, Ayik C, Göktuna G. Examination of nursing drug administration practices via central venous catheter: An observational study. J Vasc Access 2020; 21: 426-33.