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Knowledge of nursing students about central venous catheters

Studenti nege i njihovo teoretsko poznavanje centralnih venskih katetera

Suzana Mlinar, Rosanda Rašković Malnaršić

Faculty of Health Science, University of Ljubljana, Ljubljana, Slovenia

Abstract

Background/Aim. Central venous catheters (CVC) are at the crucial importance, particulary in the intensive therapy units. In order to handle a CVC safely, nursing students need to acquire theoretical and practical knowledge during the course of their studies. The aim of the study was to establish theoretical knowledge of nursing students about the procedures of nurses in placing and removing a central venous catheter (CVC), dressing the catheter entry point, the reasons for measuring central venous pressure (CVP), possible complications and risk factors for developing infections related to CVC. **Methods.** The questionnaire developed specifically for this cross-sectionl study was handed out to 87 full-time students and 57 part-time students. **Results.** The results show that all the surveyed nursing students know why chest radiography is carried out when inserting a catheter, have relatively good knowledge of CVC insertion points, procedures carried out in case of a suspected catheter sepsis and complications and risk factors for the development of infections related to CVC. However, the study show that the majority of students have insufficient knowledge of the procedures accompanying insertion of a catheter, signs that indicate correct functioning of CVC, frequency of flushing a catheter when it is not in use and the reasons for introducing an implanted CVC. **Conclusion.** Based on the results of the study it can be concluded that the second-year nursing students have insufficient knowledge of CVC. In order to correctly and safely handle a CVC, good theoretical knowledge and relevant practical experience are needed. The authors therefore believe that, in future, the classes should be organized in smaller groups with step-by-step demonstrations of individual procedures in handling a CVC, and the students encouraged to learn as actively as possible.

Key words:
students; nurse clinicians; knowledge; questionnaires; catheterization, central venous; infection; risk factors.

Apstrakt

Uvod/Cilj. Centralni venski kateteri (*central venous catheters* – CVCs) veoma su važni, naročito u jedinicama za intenzivnu negu. U cilju pravilnog rukovanja CVCs neophodno je da studenti nege steknu i teoretsko i praktično znanje tokom svojih studija. Cilj ove studije bio je da se kod studenata nege utvrdi nivo njihovog teoretskog poznavanja postupaka nege u postavljanju i izvlačenju CVC, previjanju ulaznog mesta katetera, razloga za merenje centralnog venskog pritiska (*central venous pressure* – CVP), mogućih komplikacija i faktora rizika od nastanka infekcija od CVCs. **Metode.** Urađen je upitnik specijalno za ovu unakrsnopoprečnu studiju i podeljen redovnim (n = 87) i vanrednim (n = 57) studentima. **Rezultati.** Dobijeni rezultati pokazuju da svi posmatrani studenti nege znaju zašto se sprovodi radiografija pluća prilikom postavljanja katetera, relativno dobro znaju o mestima ubacivanja CVC, procedurama koje se sprovode kada se sumnja u sepsu od katetera i komplikacije i faktore rizika od nastanka infekcija od CVC. Studija, međutim, pokazuje da većina studenata nedovoljno poznaje postupke ubacivanja katetera, pokazatelje pravilnog funkcionisanja CVC, učestalosti ispiranja katetera kada je on van upotrebe, kao i razloge za ubacivanje ugrađenog (implantiranog) CVC. **Zaključak.** Prema dobijenim rezultatima ove studije može se zaključiti da studenti II godine nege nedovoljno znaju o CVCs. Za pravilno i bezbedno rukovanje neophodno je dobro teoretsko znanje o CVCs i odgovarajuće praktično iskustvo. Autori, zato, veruju da bi ubuduće nastava trebalo da se organizuje u manjim grupama, uz postupno pokazivanje svakog pojedinačnog postupka rukovanja sa CVC i motivaciju studenata za aktivno učenje.

Ključne reči:
studenti; medicinski tehničari; znanje; upitnici; kateterizacija, centralna, venska; infekcija; faktori rizika.

Correspondence to: Rosanda Rašković Malnaršič, Faculty of Health Science, University of Ljubljana, Zdravstvena pot 5, 1 000 Ljubljana, Slovenia. Phone.: 00386 1 300 11 63. E-mail: rosanda.malnarsic@zf.uni-lj.si

Introduction

Central venous catheters (CVCs) are of crucial importance in modern medical practice, particularly in intensive therapy units. They enable intake of larger quantities of highly concentrated liquids and medications that damage peripheral veins (vesicant chemotherapy, parenteral nutrition, hypertonic antibiotic solutions), giving blood and blood product transfusions, taking blood samples for testing, monitoring hemodynamic status of critically ill patients and administering liquids and medication at a patient's home [1–4].

Despite the fact that CVC enables vitally necessary venous access, its use carries the risk of local and systemic infections [5]. CVC infections represent a serious complication in treatment, which worsens prognosis, prolongs hospitalization and increases treatment costs [6]. The highest percentage of primary blood infections are related to CVC [7]. Sepsis due to spreading of microorganisms from colonized CVCs develops in 0.9% to 8.0% of cases [8–9]. The occurrence of infection is influenced by the general condition of a patient, duration of hospitalization, anatomic catheter insertion point, number of lumens, inappropriate aseptic technique when handling CVC, type of dressing material, colonization of a catheter entry point and colonization of an attachment part of a catheter [3]. The main infection routes are extraluminal and endoluminal. Contamination risk is lowered by the use of maximal sterile barriers and the use of appropriate disinfectant [3, 10].

In a patient with an inserted CVC, the nurse carries out the aseptic technique for monitoring a catheter entry point, dressing a catheter, flushing a catheter, taking smears of a catheter entry point, adjusting the prescribed infusion liquids, parenteral nutrition, transfusion of blood and blood products, taking blood samples, measuring the central venous pressure (CVP) and application of medications. In order to handle a CVC safely, nursing students need to acquire theoretical as well as practical knowledge during the course of their studies. At the Faculty of Health Sciences, students of nursing acquire theoretical and practical knowledge in the first year of the bachelor studies in nursing. In the past, students of nursing at the Faculty of Health Sciences gained clinical knowledge and skills at clinical training in the clinical environment, due to considering this the best method for acquiring knowledge and important practical experience. Clinical situations probably do represent the best method for acquiring practical skills, however, clinical environment often does not provide optimal learning opportunities due to overcrowding and a lack of experienced clinical mentors [11]. Students often claim that they learn most when performing something on their own, which means learning through experience and solving certain problem situations [12–13].

Clinical environment and clinical situations can be successfully simulated in nursing care labs. In nursing labs, learning is active, and safe, without risks for patients safety; specific learning situations are created, possible errors of students are established and corrected and creativity of a student is encouraged. A student receives feedback from the teachers, colleagues and a "simulated" patient [14]. Successful learning in simulated situations requires clinically experienced mentors who continuously monitor changes in practice, as the scientific bases for clinical practice necessitate an understanding of biomedical science [15].

So far, no studies covering knowledge of nursing students about CVC have been published in Slovenia. Due to the importance of knowledge and the aseptic technique when handling a CVC, we were interested in how much theoretical knowledge students acquire in the first year of bachelor studies in nursing. The aim of the study was to estimate theoretical knowledge of nursing students about CVC.

Methods

This was a quantitative, single cross-section questionnaire survey of two nursing student cohorts from the Faculty of Health Science in Ljubljana, Slovenia. Eighty seven full-time and 57 part-time students of the second year of bachelor studies in nursing at the Faculty of Health Sciences (Ljubljanja, Slovenia) participated in the study. Eighty seven questionnaires were handed out to the regular students and all 87 were returned. Sixty five questionnaires were handed out to the part-time students, who returned 57 questionnaires (a return rate of 87.7%). The survey was carried out between November and December 2009. The survey was voluntary and anonymous.

The questionnaire was developed specifically for this study and included question about knowledge of procedures when inserting and dressing a catheter and about complications and risk factors for the development of infections related to CVC. The survey questionnaire included 23 questions, divided into three sections: demographic data, knowledge of procedures when inserting and dressing a CVC and knowledge of complications and risk factors for the development of infections related to CVC. The questionnaire featured closed-type and open-type questions. One question was dichotomous. A pilot study was not carried out.

The basic descriptive statistics and the *t*-test for establishing differences in average values of theoretical knowledge about CVC among the full-time and part-time students were carried out. The statistical programme SPSS v. 17 was used for data analysis.

Results

The sample included 60.4% full-time and 39.6% part-time students. Among the full-time students, 11.5% were male and 88.5% female, the age ranged from 19 to 31 years ($\overline{x}$ = 20.79; SD ± 1.61). The majority of full time students (63.2%) completed the secondary school of nursing, 17.2% completed a general upper secondary school and 19.5% other secondary schools. Among the part-time students, 24.6% were male and 75.4% female, the age ranged from 20 to 53 years ($\overline{x}$ = 29.65; SD ± 7.41). The majority (77.2%) of part-time students completed the secondary school of nursing, 8.8% completed general upper secondary school and 14% other secondary schools.

The participants' theoretical knowledge is shown in Table 1. Only 1.4% knew the veins into which CVC is most commonly inserted, 69.4% knew them partially. From 87 par-

Table 1

Descriptive statistics and differences in knowledge of Central venous catheter (CVC) between the full-time (n = 87) and part-time students (n = 57)

Questions on CVC	Number of participants (n)	Knows		Knows partially		Does not know		No answer		$\overline{x}$	SD	*t*-test	
		n	%	n	%	n	%	n	%			F	*p*
CVC insertion points	87	0		63	72.4	21	24.1	3	3.4	2.32	0.60	1.052	0.956
	57	2	3.5	37	64.9	16	28.1	2	3.5	2.31	0.54		
CVC tip positioning	87	25	28.7	0	0	42	48.3	20	23.0	1.86	0.69	0.000	0.491
	57	18	31.6	0	0	29	50.9	10	17.5	1.94	0.72		
Radiograpy following CVC insertion	87	87	100	0	0	0	0	0	0	/	/	/	/
	57	57	100	0	0	0	0	0	0	/	/		
Trendelenburg position of a patient prior to CVC insertion	87	9	6.3	0	0	37	42.5	41	47.1	3.49	0.50	6.293	.057
	57	0	0	0	0	29	50.9	28	49.1	3.26	0.91		
Valsalva manoeuvre aim	87	0	0	31	35.6	43	49.4	13	14.9	2.47	0.66	0.077	**.006**
	57	0	0	35	61.4	17	29.8	5	8.8	2.79	0.68		
Dangers of air entering the vein	87	50	57.5	0	0	31	35.6	6	6.9	1.72	0.45	6.373	0.224
	57	36	63.2	0	0	14	24.6	7	12.3	1.62	0.49		
Insertion of CVC via a tunnel aim	87	30	34.5	3	3.4	8	9.2	46	52.9	2.77	1.31	0.833	0.887
	57	15	26.3	11	19.3	3	5.3	28	49.1	2.80	1.39		
Signs of correct CVC functioning	87	8	9.2	23	26.4	48	55.2	8	9.2	2.35	0.74	0.002	**0.025**
	57	7	12.3	25	43.9	23	40.4	2	3.5	2.64	0.78		
CVC flushing frequency	87	4	4.6	0	0	78	89.7	5	5.7	1.13	0.43	18.132	**0.032**
	57	3	5.3	0	0	52	91.2	2	3.5	1.34	0.72		
Use of 10 ml syringe for flushing CVC	87	49	56.3	0	0	34	39.1	4	4.6	2.11	1.13	1.325	0.326
	57	28	49.1	0	0	24	42.1	5	8.8	1.92	1.07		
Frequency of replacing infusion system	87	39	44.8	0	0	43	49.4	5	5.7	2.31	0.51	1.592	0.287
	57	34	59.6	0	0	18	31.6	5	8.8	2.60	2.37		
Stoppers with no-return valves frequency replacing	87	24	27.6	0	0	58	66.7	5	5.7	1.83	1.55	0.106	0.339
	57	25	43.9	0	0	28	49.2	4	7.0	1.61	0.75		
Transfusion	87	48	55.2	0	0	34	39.0	5	5.7	2.51	0.70	0.882	0.521
	57	32	56.1	0	0	19	33.4	6	10.5	2.43	0.75		
Reason for stopping application of medications through CVC	87	9	10.3	0	0	75	86.2	3	3.4	2.61	0.86	11.350	0.113
	57	12	21.1	0	0	43	75.4	2	3.5	2.83	0.65		
Purpose of measuring CVP	87	31	35.6	0	0	31	35.6	25	28.7	1.60	0.78	0.152	**0.014**
	57	33	57.9	0	0	14	24.6	10	17.5	1.93	0.80		
Use of sterile gloves in CVC dressing	87	54	62.1	0	0	33	37.9	0	0	1.07	0.26	136.489	**0.000**
	57	51	89.5	0	0	4	7.0	2	3.5	1.38	0.49		
CVC dressing frequency	87	32	36.8	0	0	54	62.1	1	1.1	3.09	4.28	4.186	0.314
	57	17	29.8	0	0	40	70.2	0	0	2.43	2.94		
Disinfecting entry point in CVC dressing	87	58	66.7	0	0	28	32.2	1	1.1	2.74	0.52	2.772	0.286
	57	44	77.2	0	0	13	21.8	0	0	2.64	0.55		
Complications in patients with inserted CVC	87	4	4.6	83	95.4	0	0	0	0	5.67	2.34	0.219	0.059
	57	0	0	57	100.0	0	0	0	0	6.43	2.33		
Risk factors for CVC infections	87	2	2.3	81	93.1	0	0	4	4.6	2.18	0.57	3.646	0.239
	57	0	0	52	91.2	0	0	5	5.8	2.07	0.45		
The most common paths for CVC infections (extraluminal)	87	38	43.7	0	0	42	48.3	7	8.0	2.64	4.56	0.863	0.563
	57	28	49.1	0	0	22	38.7	7	12.3	3.61	13.85		
Procedures with patients in case of suspected catheter sepsis	87	4	4.6	78	89.7	0	0	5	5.7	1.93	0.37	2.462	0.177
	57	6	10.5	49	86.0	0	0	2	3.5	2.01	0.32		

ticipants 63.2% of the full-time and 84.2% of the part-time students knew that a CVC is inserted into the subclavian vein; 42.5% of the full-time and 49.1% part-time students knew that it is inserted into the jugular vein and 23% of the full-time and 40.4% part-time students knew that it is inserted into the femoral vein; 28.7% of the full-time and 31.6% part-time students knew that, as a rule, the tip of an inserted CVC lies in the superior vena cava; 48.3% of full-time and 50.9% part-time students did not know this fact. All the surveyed students knew that following insertion of CVC into the subclavian vein or the superior vena cava, a radiography of the lungs and the heart is carried out in order to check the position of a catheter. Prior to CVC insertion, a patient is placed into the Trendelenburg position with the aim to prevent air from entering blood stream and the occurrence of pulmonary embolism; only 6.3% of the full-time and none of the part-time students knew this. None of the participants knew the purpose of the Valsalva maneuver

when inserting and removing CVC, 35.6% of the full-time and 61.4% part-time students gave a partially correct answer. A total of 14.9% of the full-time and 19.3% part-time students of the participants knew that the Valsalva breathing technique causes a rise in intrathoracic pressure; 20.7% of the full-time and 31.6% of the part-time students knew that it diminishes blood flow to the heart and 29.9% of the full-time and 45.6% part-time students knew that the Valsalva maneuver is performed in order to prevent air from entering blood stream and to prevent air embolism. The danger of air entering CVC is higher when CVP is lower; a correct answer was given by 57.5% of full-time and 63.2% part-time students; 34.5% of the full-time and 26.3% part-time students knew why a doctor decides to insert CVC through a tunnel under the skin.

Only 9.2% of the full-time and 12.3% part-time students knew all the signs indicating correct functioning of CVC; 26.4% of the full-time and 43.9% part-time students provided a partially correct answer. A total of 66.7% of the full-time and 84.2% part-time students knew that when CVC functions correctly, needle aspiration results in blood in a syringe; 54% of the full-time and 59.6% part-time students knew that in this case, infusion runs well; 43.7% of the full-time and 57.9% part-time students knew that blood returns into the infusion system when bottle is lowered below the level of a patient's heart, and 54% of the full-time and 40.4% part-time students knew that a patient does not report discomfort or have signs of other complications. Only 4.6% of the full-time and 5.3% part-time students correctly answered the question on how often CVC needs to be flushed when not in use. A total of 56.3% of the full-time and 49.1% part-time students knew that a 10 ml syringe is used to flush CVC, as these results in lower pressure in the lumen of a catheter and consequently lowers the possibility of catheter damage. A total of 44.8% of full-time and 59.6% part-time students knew that the frequency of replacing infusion systems, stopcocks and splitters depends on the type of liquid infused *via* CVC; 27.6% of the full-time and 43.9% part-time students knew the stoppers with non-return valves for syringe handling need to be replaced every 72 hours.

A total of 55.2% of full-time and 56.1% part-time students knew that transfusions of blood and blood products are applied and blood samples taken *via* CVC only if other options are not available; 10.3% of full-time and 21.1% part-time students knew that when resistance is felt to applying medication *via* CVC, application must be stopped immediately and a doctor notified. A total of 35.6% full-time and 57.9% part-time students knew the purpose of measuring CVP; 35.6% full-time and 24.6% part-time students gave a wrong answer, while 62.1% full-time and 89.5% part-time students knew that sterile gloves must be used when dressing CVC. A total of 36.8% full-time and 29.8% part-time students knew that dressing of CVC entry point should be carried out as needed. A total of 66.7% full-time and 77.2% part-time students knew that when dressing CVC, entry point should be disinfected three times.

Only 4.6% full-time students knew all the listed most common complications with CVC; 95.4% full-time and all part-time students knew them partially. Infections were listed by 95.4% full-time and 94.7% part-time students, clogging of a catheter by 79.3% of full-time and 71.9% part-time students, catheter falling out by 73.6% full-time and 66.7% part-time students, wrong direction of a catheter 70.1% of full-time and 45.6% part-time students, hematoma by 55.2% full-time and 66.7% part-time students, catheter sepsis by 57.5% full-time and 61.4% part-time students and air embolism by 63.2% full-time and 45.6% part-time students.

Only 2.3% full-time students knew all the listed risk factors for the development of infection, related to CVC; 93.1% full-time and 91.2% part-time students knew risk factors partially; 90.8% full-time and 84.2% part-time students listed incorrect cleaning of CVC entry point as a risk factor for the development of infection; 73.6% full-time and 78.9% part-time students listed failure to use the aseptic technique and maximum sterile barriers when handling CVC, 77% full-time and 66.7% part-time students listed incorrect handling with CVC and 20.7% full-time and 17.5% part-time students listed frequent use of CVC. The most common infection route for CVC is the extraluminal route; 43.7% full-time and 45.8% part-time students gave a correct answer.

Only 4.6% full-time and 10.5% part-time students knew all the listed procedures carried out in case of a suspected catheter sepsis; 89.7% of full-time and 86% part-time students knew the procedures partially. A total of 65.5% of full-time and 59.6% part-time students knew that in case of a suspected catheter sepsis, two hemocultures are taken (one through CVC and the other from the patient's peripheral vein); 54% full-time and 77.2% part-time students knew that a catheter tip needs to be sent for microbiological tests; 32.2% of full-time and 24.6% part-time students knew that a smear of CVC entry point is taken in case signs of inflammation are present.

The *t*-test for independent samples showed a statistically significant difference between the full-time and part-time nursing care students in the following aspects of knowledge CVC (see Table 1). Part-time students had important knowledge of the purpose of the Valsalva maneuver ($F = 0.077$, $p = 0.006$; 95% CI 0.545–0.094), signs of correct functioning of CVC ($F = 0.002$, $p = 0.025$; 95% CI 0.545–0.037), frequency of flushing the CVC ($F = 18.132$, $p = 0.032$; 95% CI 0.600–0.069), purpose of measuring the CVP ($F = 0.152$, $p = 0.014$; 95% CI 0.431–0.181) and importance of wearing sterile gloves when dressing a CVC ($F = 136.489$, $p = 0.000$; 95% CI 0.401–0.018).

Discussion

The study shows that the majority of full-time and part-time second-year nursing students completed the secondary nursing school. Such an educational structure was expected, as the study programme of nursing in Slovenia is mostly chosen by candidates who have completed the secondary nursing school. The result analysis showed that part-time students more frequently gave correct answers to some questions.

In general, the students' knowledge about CVC is relatively insufficient. Only 3.5% part-time students know all the typical CVC inserting spots, the majority of participants only partially know them. Some of the participants do not even possess knowledge of all the Latin names for veins used for inserting CVC, which indicates insufficient knowledge of anatomy and physiology.

Following CVC insertion, the tip of a catheter lies in the superior vena cava. Only 28.7% of full-time and 31.6% part-time students gave this answer. The recommended position of the tip is in the lower third of the superior *vena cava*, immediately preceding the entry into the right atrium [16]. When inserting CVC into the femoral vein, the tip of a catheter lies in the inferior *vena cava* [2].

The Trendelenburg position is known as the position of the body with the head downwards, which is achieved by lowering the head of the bed by 10 to 20 degrees [17] or 10º–30º [18]. The patient is placed in deep Trendelenburg position prior to insertion and during removal of CVC in order to prevent air embolism [19]. Only a small percentage of full-time students knew that a patient should be placed in the Trendelenburg position in order to prevent air from entering blood stream and air embolisms. None of the part-time students knew the answer to this question, which was very surprising.

The Valsalva maneuver causes pressure in the thorax to rise and blood flow to the heart to diminish, which lowers the possibility of air entering through an open needle. A couple of seconds following CVC removing, the Trendelenburg position and the Valsalva maneuver prevent air from entering the space of a catheter placement and enable closing of the vein [19]. A good third of the participants only partially knew the effects of the Valsalva maneuver. None of the students listed all the three correct claims, which indicated a poor knowledge of physiology. The danger of air entering blood stream and development of pulmonary embolism is higher, if CVP is lower; 57.5% full-time and 63.2% part-time students gave a correct answer. Part-time students had a higher number of correct answers. Radiography control of catheter position is needed for all central venous catheters supplying liquids into the subclavian vein or the superior *vena cava* [20]. All the participants knew that radiographic imaging is used to control the position of a catheter, which is commendable.

Only one third of the participants knew that the doctor decides on insertion of a tunnelled central venous catheter when the patient requires long-term and intensive treatment. It is true that full-time nursing students are rarely faced with implanted catheters in clinical practice; however, within the framework of lab classes, the students are given enough information on this type of catheter.

Prior to each use of CVC for applying medications or infusion liquids, it is necessary to check the passage through and correct functioning of a catheter. Signs indicating a partial or total occlusion of catheter need to be considered seriously and a full passage through a catheter established [21]. Approximately 10% of the participants stated that correct functioning of CVC may be deduced from the following facts: when aspiration results in blood in a syringe, when infusion is running, when blood returns to the infusion system after a bottle has bee lowered below the level of a patient's heart and when a patient does not report any discomfort or has signs of other complications. A good third of the participants only partially knew these signs. Flushing CVC is necessary to ensure flow through a catheter [22]. It prevents formation of fibrin linings, even though fibrin linings occur in all CVCs to a certain degree [2]. Depending on the type of catheter 0.9% NaCl and heparin solution are used for flushing. Commonly accepted flushing methods are flushing with positive pressure and the stop-start technique [4]. It is accepted that flushing CVC twice a week prevents catheter clogging. The survey results show that only 4.6% full-time and 5.3% part-time students correctly answered the question on CVC flushing frequency when it is not in use.

It is very important that not too great force is used when flushing CVC in order to prevent catheter ruptures and catheter embolism. Many instructions recommend the 10 mL syringe as the smallest admissible [4]. In our survey, a good half of the participants correctly answered the question about why a 10 mL syringe is used to flush the catheter.

With clear infusion liquids, it is necessary to replace the system and connectors every 72 hrs, except in case of disconnecting infusion catheter from CVC [10]. In general, infusion systems are replaced after expiration of the prescribed time period for system use (every 12, 24, 48 or 72 hrs). When blood and blood products or fat emulsions combined with amino acids and glucose are given through a catheter, infusion system needs to be replaced every 24 hrs [6]. When propofol infusion is given, infusion system needs to be replaced every 6 to 12 hrs [23]. In our survey, half of the participants correctly answered that the frequency of replacing infusion system and infusion connectors depends on the type of infusion liquid running through CVC.

Stoppers with non-return valves need to be replaced less frequently than infusion systems, which means every 72 hrs [2, 3]. A good third of the participants knew that stoppers with non-return valve need to be replaced every 72 hrs. As expected, the part-time students more frequently provided a correct answer. Over half of the participants knew that blood or blood product transfusion and taking of blood samples are carried out *via* a CVC only if no other option is available.

Central venous pressure is pressure inside the superior vena cava and the inferior vena cava with usually equals the pressure in the right atrium. CVP values depend on the balance between the venous inflow into the right atrium and the pumping ability of the right ventricle. CVP is a good indicator of the fluid balance in the body and the heart function, especially right-sided heart failure and pulmonary edema [3, 24]. A total of 35.6% of full-time and 57.9% part-time students knew why CVP is measured. This question was also more frequently answered correctly by the part-time students.

Many studies support the use of bandages; however, bandage type remains disputed [25]. To cover CVC entry point, transparent bandages that enable monitoring of a catheter entry point and purpose bandages that ensure CVC is carried out safely (even without sutures) are used [26]. Transparent bandages are replaced every 7 days or more frequently in case of inflammation or wet, dirty or bloody bandages [10, 26]. In our survey, the majority of participants knew that sterile gloves are required when dressing CVC entry point, which is commendable. A total of 66.7% full-time and 77.2% part-time students know that catheter entry point should be cleaned/disinfected at least three times. A good third of the participants knew that CVC dressing should be carried out as required, which indicated insufficient knowledge.

Treatment of patients with CVC must be oriented towards lowering the risk for the development of complications and recognizing the signs of complications as soon as possible [4]. The study results show that 95.5% of full-time and all the part-time students have very good knowledge of the most common complications occurring with a CVC.

Approximately 20% of nosocomial infections develop due to the use of CVC. A 4-year study carried out in England showed that 43% of infections are related to CVC [27]. Colonization of the skin at CVC insertion spot plays an important role in the colonization of a catheter and entry of infection into blood stream [28]. The results of our survey show that the participants have good knowledge of the majority of risk factors for the development of CVC infections. Incorrect cleaning of catheter entry point and incorrect handling of CVC by the nurse were the most commonly cited risk factors. The extraluminal route was cited as the most common route of CVC infections.

In a suspected catheter sepsis, taking two hemocultures is recommended (one through a catheter and the other from a peripheral vein); with signs of inflammation, a smear of catheter entry point should be taken and catheter tip sent for semiquantitative culture according to Maki [3, 19]. Only 4.6% full-time and 10.5% part-time students knew all the procedures carried out in a suspected catheter sepsis; the majority of participants provided partially correct answers. Taking blood samples for hemoculture and sending a catheter tip for microbiological analysis.

Conclusion

Monitoring and handling CVC represent very important and responsible aspects of the nurses' work. CVC infections are a dangerous, sometimes even fatal complication in treating critically ill patients. Many complications can be prevented or at least limited by high-quality care of CVC and high-quality nursing care of a patient. The results of our study show that the surveyed nursing students have insufficient knowledge of CVC. Correct and safe handling of the CVC is not possible without good practical and theoretical knowledge. The researchers believe that in order to improve the knowledge of nursing students, it is necessary to carry out practical classes in smaller groups, with step-by-step demonstration of individual procedures in handling CVC and to encourage students to learn as actively as possible.

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