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Students' Knowledge of Peripheral Intravenous Cannulation at A Private University in Seremban, Negeri Sembilan, Malaysia

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Background: Healthcare providers must have the knowledge to carry out clinical procedures. Placing and maintaining intravenous (IV) infusion is one of them. To perform it, conceptual knowledge is an elementary requirement.

Methods: This is a descriptive quantitative study using a self-administered questionnaire. Section A consists of four items detailing medical students' socio-demographic data such as age, gender, ethnicity, and nationality. Section B includes 17 True/False items related to knowledge and understanding of peripheral intravenous cannulation (PIVC). Sixty-nine semester 6 medical students were recruited. The goal of the research was to determine their knowledge of PIVC and if there is an association between socio-demographic data and knowledge of PIVC.

Results: All 100% (n=69) respondents were aware of self-introduction, clarification of patient's identity, obtaining verbal consent, and hand hygiene importance. The majority (98.6%, n=68) had the knowledge to clean the insertion site before performing the procedure, aseptic technique maintenance, and gloves donning. More than half (53.6%; n=37) of respondents were not aware that an 18-gauge cannula was commonly used in adults for PIVC. Overall, findings showed 40.6% (n=28) of respondents have adequate knowledge about PIVC. There was a weak negative correlation indicating an association between socio-demographic variables and knowledge about PIVC ($r = -.274$, $n=69$, $p<0.05$).

Conclusions: The majority of semester 6 year 3 medical students in a private university in Seremban, Negeri Sembilan, had good knowledge of PIVC. Teaching strategies by nursing lecturers can be improved further, for example, role-playing which can increase students' engagement and encourage critical thinking. This is to ensure that medical students are equipped with sufficient theoretical knowledge as it is important to produce doctors with great quality, confidence, and calibre.

Keywords: *knowledge, medical student, perception, peripheral intravenous cannulation, university.*

INTRODUCTION

Healthcare providers including doctors, nurses, and even medical or nursing students, must have the required knowledge to function professionally while carrying out clinical procedures. It is a prerequisite to be skillful and competent in order to ensure safe and quality care are delivered to the patients. One of the important clinical skills that should be developed is placing and maintaining intravenous (IV) infusion. Annually, approximately 60% of the inpatients undergo peripheral IV cannulisation to enable them to receive therapeutic therapy intravenously.[1]

Most medical education literature recorded that having conceptual knowledge is an elementary requirement to gain competency in performing any procedural skills.[2] In Miller's Pyramid, out of the four levels, the first two lower levels at the bottom concentrate on cognition.[3] The base represents the field "Knows", meaning the student has fact-based knowledge of a particular skill. In the second level, the student "Knows How" meaning that, a particular skill is executed theoretically. Cognition includes an explanation regarding the procedure, the indications, contraindications, and site of cannulation. The last

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top two levels pay more emphasis on psychomotor skills. Thus, to ensure procedural skills are taught effectively, medical educators should focus on both the cognitive aspect of the procedure and the psychomotor component.[3]

In the modern medical world, millions of patients receive IV therapy, which is a method of parenterally administering fluids and additives into a vein.[4] Hence, one of the essential clinical skills that a healthcare provider must develop is the insertion of a peripheral IV cannula. The cannula is a small and hollow plastic-like device that is inserted by advancing it over a sharp rigid stylet or needle that penetrates a peripheral vein through the skin.

The healthcare providers' approach and understanding of peripheral intravenous cannulation (PIVC) are very crucial. It is one of the most common invasive procedures performed to maintain or restore fluid and electrolyte balance when there is inadequacy or contraindication for oral replacement. This includes fluid infusion, blood transfusion, administration of medication, and nutritional support. However, when the integrity of the skin is compromised with the usage of any venous access such as needle and cannula, the patient shall be at risk for infection such as phlebitis, subcutaneous infiltration, and thrombus formation[4] as the vein wall has been traumatised. Thus, all levels of healthcare providers must possess the latest knowledge in practising PIVC for safe clinical practice.

As per evidence-based guidelines, adequate knowledge and skills are required to carry out the PIVC procedure.[5] Though there is no explicit consensus on how clinical evaluation or assessment shall best be attained, it is vital to ensure these students are well-equipped with the required knowledge and skills at the end of each course.[6] Despite the availability of proper guidelines in PIVC, the effectiveness of implementation in the clinical area has received comparatively little attention.[7] Excluding various patient-related factors accounting for peripheral IV cannula-related complications, knowledge deficiency in peripheral IV cannula management is also known as one of the reasons for complications to occur.[5] As such, the rate of associated complications concerning PIVC is on the rise and affecting patients' safety. We aimed to identify if the semester 6 (Year 3) undergraduate medical students were equipped with theoretical knowledge in managing a patient who requires PIVC after they have undergone the teaching and learning session.

METHODS

A self-administered questionnaire consisting of two sections; Section A and Section B was utilised. Section A consists of socio-demographic data with four items that include age, gender, ethnicity, and nationality. Section B comprises 17 True/False items related to knowledge and understanding about PIVC. The questionnaire was adapted and modified from a study done by Mohd Ghazali and Arbaee[1] after obtaining permission from the authors via email. The questionnaire was modified to suit the local context. It is unidirectional where all "True" is the correct answer. The variables were measured as 1 = True and 0 = False/Don't know. No psychomotor skills or practical session was required. The knowledge level was measured using the McDonald's standard of learning outcome.[8]

The scores were categorised as:
<60% = very low knowledge (answered 10 and below number of questions correctly)
60-69% = low knowledge (answered 11 number of questions correctly)
70-79% = moderate knowledge (answered 12 or 13 number of questions correctly)
80-89% = high knowledge (answered 14 or 15 number of questions correctly)
90-100% = very high knowledge (answered 16 or 17 number of questions correctly)

A pilot study was conducted on 10% of the population sample of the same university but from a different semester of undergraduate medical students. A test-retest reliability method was utilised to enable the researchers to assess the stability of the instrument and was done in a period of two-week intervals. Before the distribution of the questionnaires, the students were given clear instructions regarding the requirements of the study. The pilot study helped in identifying weaknesses and errors, thus, the researchers made minor amendments before the actual study was carried out.

The content of the questionnaire was validated by an expert from the surgical department of the university. The opinion of the expert was taken into consideration in the relevance of the items to ensure the questions were fair and suitable to assess the undergraduate medical students' knowledge level. The reliability of the questionnaire was assessed with a pilot test-retest study conducted at two-week interval checks using the Pearson correlation coefficient denoted by r to find the strength of the relationship between the two sets of data for test and retest. Although the strength was moderately positive, 0.518, the questionnaire was found to fit with what nursing lecturers have taught and what the medical students should know, and it was finalised with 17 questions.

Data collection was done upon approval by the university's Joint Committee on Research & Ethics. The study project number is BN I/2018 (PR-35). Suitable time was allocated to avoid time conflicts between data collection and other appointments. A calm and conducive environment was provided to avoid any disruption that may affect the validity of the results. An explanatory statement was provided to the medical students who met the inclusion criteria. Written consent was taken before the commencement of the study. The researcher was present to answer any queries while the medical students were completing the questionnaire which took about 15 minutes.

Permission was also obtained to conduct the pilot study from the dean of the research site. Potential respondents were informed verbally of the purpose of this study and written consents were prepared and distributed for the potential respondents to participate and allow the findings to be published. They were also given the right to refuse. Confidentiality was maintained with the assurance of anonymity.

To analyse the data, the Statistical Packages for the Social Sciences (SPSS) version 19.0 was utilised. Socio-demographic data were analysed using descriptive statistics for frequency, mean, and standard deviation (SD). For the inferential data to identify any significant association between socio-demographics and knowledge in PIVC of the medical students, the Pearson correlation test was utilised.

Description of the conducted teaching session

IV cannulation is introduced to undergraduate medical students in the university while they are in semester 5 (pre-clinical year). On starting the clinical phase, the medical students will have an interactive teaching and learning session on this topic, conducted by the Clinical Skills & Simulation Centre (CSSC) nursing lecturers during the Internal Medicine posting in semester 6 of their third year. The didactic approach is to teach theoretical knowledge using Microsoft PowerPoint presentation slides where the nursing lecturer will deliver information about the indications and contraindications of PIVC; instruments used in the procedure such as basic parts of intravenous cannulas and their different diameters and gauges; relevant human clinical anatomies such as common sites and suitable veins selection for PIVC; the expected outcome of PIVC; benefits and risk complications of PIVC; IV infusion calculation; IV drug calculation; the significance of safe technique and methodical approach to PIVC; the importance of self-introduction to the patient before PIVC; obtaining informed consent; and post-procedure documentation. The taught procedure is then demonstrated by the nursing lecturer using teaching aid such as upper limb task trainer (medium-fidelity simulator) and equipment that is required for PIVC. The medical students will then be given some time to practice the procedure on the limb task trainer in small groups of five to six.

RESULTS

Socio-demographic characteristics data

Table I: Socio-demographic Characteristics (n=69)

VARIABLES	CATEGORIES	MIN	MAX	FREQUENCY (n)	PERCENTAGE (%)	MEAN	SD
Age		21	28			22.62	1.273
	21-22 years old			34	49.3		
	23-24 years old			32	46.4		
	>25 years old			3	4.3		
Gender	Male			27	39.10		
	Female			42	60.90		
Ethnicity	Malay			13	18.80		
	Chinese			40	58.00		
	Indian			14	20.30		
	Others			2	2.90		
Nationality	Malaysian			65	94.20		
	Others			4	5.80		

The socio-demographic characteristics of the respondents are summarised in Table I. The mean age was 22.62 (SD=1.273), ranging from 21 to 28 years old. The age of the respondents was categorised into three. There were 49.3% (n=34) respondents between the age of 21 to 22 years old, 46.4% (n=32) between the age of 23 to 24, and 4.3% (n=3) were above the age of 25. There were 60.9% (n=42) female respondents and 39.1% (n=27) male respondents. Out of 69 respondents, 58% (n=40) were Chinese, 20.3% (n=14) were Indians, 18.8% (n=13) were Malays, and 2.9% (n=2) were from other ethnicities. Malaysians made up 94.2% (n=65) of the respondents while 5.8% (n=4) were from other nationalities.

Knowledge about PIVC

Table II: Knowledge about PIVC (n=69)

PART B	QUESTIONS	RESPONSE	FREQUENCY (n)	PERCENTAGE (%)
B1	Self-introduction to the patient and clarification of the patient's identity is important before performing intravenous cannulation.	True	69	100
		False	0	0
B2	The patient should be informed of the procedure and verbal consent should be obtained.	True	69	100
		False	0	0
B3	18G cannula is suitable to be used for adult peripheral intravenous cannulation.	True	32	46.4
		False	37	53.6
B4	Factors that influence choice of cannula are the purpose of cannulation, and size of the vein to be cannulated.	True	64	92.8
		False	5	7.2
B5	Cephalic and basilic veins on the forearm are frequently used in intravenous cannulation.	True	43	62.3
		False	26	37.7
B6	Peripheral intravenous cannula cannot be left in-situ for more than 72 hours irrespective of the presence of infection.	True	45	65.2
		False	24	34.8
B7	Phlebitis is the most identifiable infection related to intravenous cannulation.	True	65	94.2
		False	4	5.8
B8	Hand hygiene before performing intravenous cannula insertion is important to reduce risk of infection.	True	69	100
		False	0	0
B9	Maintaining aseptic technique during insertion of intravenous cannula helps in reducing risk of infection.	True	68	98.6
		False	1	1.4
B10	Wearing gloves during insertion of intravenous cannula is advisable.	True	68	98.6
		False	1	1.4
B11	Skin preparation of the insertion site is required before intravenous cannulation is performed.	True	68	98.6
		False	1	1.4

B12	Multiple attempts of intravenous cannulation increases the risk of phlebitis, thrombosis, and cannula related infection.	True	65	94.2
		False	4	5.8
B13	Change to a new cannula if the first attempt of intravenous cannulation failed.	True	60	87
		False	9	13
B14	Usage of transparent dressing will help in recognising early signs and symptoms of infection.	True	64	92.8
		False	5	7.2
B15	Removing intravenous cannula immediately if it is not in use will help to reduce risk of infection.	True	58	84.1
		False	11	15.9
B16	Staphylococcus aureus is the most common organism identified with infected intravenous catheter.	Tue	57	82.6
		False	12	17.4
B17	Patient education on care of intravenous cannula helps in reducing risk of infection.	True	64	92.8
		False	5	7.2

Table II summarises the findings for knowledge of PIVC. All respondents, 100% (n=69), were aware of self-introduction to the patient, clarification of the patient's identity, and obtaining verbal consent before the procedure. The respondents (100%, n=69) also knew about the importance of hand hygiene to reduce the risk of infections.

The majority, 98.6% (n=68) had knowledge about the need to don gloves for the procedure, to clean the insertion site before the procedure is performed, and to maintain an aseptic technique to reduce the risk of infection.

More than half of the respondents (53.6%, n=37) were not aware that an 18-gauge cannula was commonly used in adults for PIVC. In the selection of veins for PIVC, only 62.3% (n=43) of respondents knew that cephalic and basilic veins were the common ones selected for PIVC.

Regarding reducing infections, 65.2% (n=45) respondents knew to remove the cannula 72 hours after the insertion. The other 34.8% (n=24) were unaware of this. We found that 15.9% (n=11) were unaware that immediate removal of unused peripheral intravenous cannula helps to reduce risk of infections but 82.6% (n=57) knew that *Staphylococcus aureus* was the most common organism related to infected IV catheters.

Total marks scored

Table III: Total Marks Scored (n=69)

MARKS SCORED	FREQUENCY (n)	PERCENTAGE (%)
10	1	1.4
11	2	3.0
12	1	1.4
13	11	15.9
14	19	27.5
15	9	13.0
16	2	3.0
17	24	34.8

Table III shows the total marks scored for this study. Scores ranged from 10 to 17 and 34.8% (n=24) of respondents scored full marks.

Total knowledge scored

Table IV: Total Score of Knowledge about PIVC (n=69)

KNOWLEDGE LEVEL	FREQUENCY (n)	PERCENTAGE (%)	MEAN	SD
			14.9	1.824
<60% = very low knowledge (answered 10 and below number of questions correctly)	1	1.4		
60-69% = low knowledge (answered 11 number of questions correctly)	2	2.9		
70-79% = moderate knowledge (answered 12 or 13 number of questions correctly)	12	17.4		
80-89% = high knowledge (answered 14 or 15 number of questions correctly)	28	40.6		
90-100% = very high knowledge (answered 16 or 17 number of questions correctly)	26	37.7		

The total knowledge score for this study is shown in Table IV. Overall, the mean score for knowledge level was 14.9 (SD=1.824). Most respondents (40.6%, n=28) had high knowledge, scoring between 80-89% and 37.7% (n=26) had very high knowledge, scoring 90-100%. Meanwhile, 17.4% (n=12) were found to have moderate knowledge with a score between 70-79%. Two students had low knowledge scores (60-69%) and one with very low knowledge (<60%).

Inferential analysis: Pearson correlation between demographic variables and knowledge level

Table V: Pearson Correlation between Socio-demographic Variables with Knowledge about PIVC

	PEARSON CORRELATION VALUE (r)	SIGNIFICANT VALUE (p<0.05)
Age	.059	.628
Gender	-.274*	.022
Ethnicity	.028	.817
Nationality	-.192	.115

** Correlation is significant at the 0.05 (2-tailed)*

Table V demonstrates the association between the demographic data and respondents' knowledge of PIVC. The significant value was set at a value of 0.05 ($p<0.05$). A Pearson's correlation value (r) test was conducted to determine any association between the socio-demographic variables of the 69 respondents and their knowledge. The findings showed that there was a weak negative correlation between gender and knowledge of the respondents ($r = -.274$, $n=69$, $p<0.05$).

DISCUSSION

Miller indicated the importance of cognition in clinical skill performance by placing it at the bottom of the Miller's Pyramid whereby "Knows" represents factual knowledge of a skill, and "Knows How" corresponds the applied knowledge before demonstrating the skill.[3] From this study, the findings suggested that the majority of the semester 6 undergraduate medical students had high knowledge of PIVC.

The semester 6 medical students scored high (100%, n=69) in areas such as self-introduction, patient identity clarification, and obtaining verbal consent before proceeding with the IV cannulation procedure. In contrast, an African study found that only 23% of the patients seen by medical students were consented and given clear explanation about the procedure. Providing information on the procedure must be concise and instructive to ensure patients' understanding and to prevent them from becoming unduly disturbed and anxious.[4]

In this study, all (n=69) of the medical students were aware of the importance of handwashing before performing the procedure compared to a study in India where only 57% (n=100) interns had the knowledge of hand hygiene while another 30% were not aware of it, and the remaining had no idea about it.[9] A Caribbean study stated that only 56% of their respondents practised both handwashing and donning of gloves while performing cannulation.[10] Precautions, in order to control infections must be taken seriously by healthcare personnel, for example, the application of medical asepsis such as handwashing before and after attending to the patients.[4] The same article also reported that 30.4% of healthcare workers did not practice the aseptic technique while inserting an IV cannula.[10] Perhaps the early introduction to IV cannulations in semester 5, the pre-clinical year at our premise, played a role in the positive results we obtained during our research which also supports spiral teaching and learning. Spiral curricula emphasise learning by associating new knowledge with students' previous cognitive construction.[11] This will promote great understanding and knowledge retentiveness.

It was revealed that 53.6% (n=37) of the medical students were not aware that an 18-gauge IV cannula was the suitable size commonly used in adults. This is in contrast to an Indian study where 60% (n=100) of respondents agreed that the said size is commonly used as compared to the other sizes of cannula.[9] Needles for venepuncture were available in a variety of diameters or gauges, and sizes 18, 20, or 22 gauges were widely used for adults.[4] The choice of appropriate cannula size for different patients and situations may be an area identified that nursing teachers could improve when planning future sessions.

Cephalic and basilic veins are commonly used in IV therapy.[12] This study disclosed that only 62.3% (n=43) of the medical students had the knowledge that cephalic and basilic veins on the forearm are frequently used in IV cannulations. It showed that the students were not really equipped with the anatomy knowledge which they had learned during basic sciences training phase. In an Iranian study, negative attitudes have been identified among medical students towards anatomical study and that this lack of optimisms in the application of basic sciences leads to the inconsistency between theoretical and clinical features.[13]

Due to the rising incidences of phlebitis in peripheral IV cannula, it was expected that most respondents in this study be cognizant of it. Majority (94.2%, n=65) of the medical students in this study were equipped with this knowledge. This is compatible with the study conducted by Kumar, Jaladhar, and Bendigeri which reported that 80% (n=100) of the interns in their study were aware of the complication.[9]

Regarding knowledge about *S. aureus* being the most common organism identified related to infected PIVC, some (17.4%, n=12) medical students were not aware of it. In a 2016 United States (US) study, it was concluded that the main source of bloodstream infection in patients on peripheral IV cannulas was *S. aureus*.[14] Similarly, the Health Quality & Safety Commission New Zealand reported a case whereby the blood culture results from a systemically sick patient was found to grow *S. aureus*, and the source was identified to be from the infected PIVC site from his previous hospital admission.[15]

This study also disclosed that only 65.2% (n=45) of the semester 6 medical students had the knowledge of the

need to replace the IV cannula every 72 hours. Timby and Smith[4] stated that the tubings and cannulas should be replaced every 72 hours to decrease the potential for infection though the actual parameters are based on the policy of the agency. Immediate removal of unused IV cannula was also another step to be taken to minimise risk of infection as it was found that 30-50% of unused IV catheters which were left in-situ either developed complications or failed to work before completion of treatment which required reinsertion of a new set.[16] We found that 84.1% (n=58) of medical students in this study identified the need to promptly remove unused IV cannulas.

The majority of medical students in this study (92.8%, n=64) identified that the usage of transparent dressing does help to identify early signs and symptoms of infection. This was similar to a study carried out in the US that stated this type of film dressing enables healthcare providers to do daily inspections of the cannula site without the need to remove the dressing. Furthermore, a transparent dressing also provides a barrier to contamination from air and external pathogens.[17]

With regard to socio-demographic characteristics, this study showed that there was a weak negative correlation between gender and knowledge of the respondents ($r=.274$, $n=69$, $p<0.05$). A study which involved nurses in a local teaching hospital showed a positive correlation between age and knowledge ($r=0.123$, $p=0.286$), wherein the older the respondents the higher the knowledge on PIVC insertion.[18] However, in our study, age, ethnicity, and nationality showed no significant association with the knowledge of the medical students about PIVC. This is compatible with a Nepal study that was carried out among nursing students.[19]

Overall, the findings showed the medical students in this study had good knowledge about PIVC with scores between 80-89% compared to the medical students in a study by Katowa-Mukwato and Banda.[2] In that study, the medical students scored 76.7% in a Multiple-Choice Questions knowledge test on IV cannula insertion. However, though this study reveals that our students have good knowledge, there are still areas identified that nurse lecturers can focus on for improvement.

One out of 69 students failed to observe the importance of maintaining aseptic technique during skin preparation of the insertion site and wearing gloves during cannula insertion. This was identified as an ethical concern that breached patient safety practices. The authors explored this issue and identified the student's lack of knowledge as learning gap. Remedial education was carried out to bridge the gap in knowledge which may hinder academic progress and future practices.

LIMITATIONS

- This study specifically assessed theoretical knowledge and did not include the competency demonstrated on the procedural skill after the teaching and learning.
- The sample size was small and was conducted on students during one posting from one cohort.
- Participants included in the study were from a one private university, hence, the findings cannot be generalised.

CONCLUSION

PIVC is known to be one of the most common clinical skills performed by healthcare providers. This descriptive study concluded that the majority of the semester 6 undergraduate medical students in our premise had high knowledge about PIVC. However, more than half lacked knowledge regarding size of IV cannula commonly used in adults. The teaching contents of nursing lecturers can be improved further, for example, by role-playing which can increase students' engagement and encourage critical thinking and ensure students are fully-equipped with sufficient theoretical knowledge which is the foundation of being competent in all procedural clinical skills. With rising complaints and high patient expectations in this era, it is of paramount importance to produce doctors with great quality, confidence, and calibre. Further studies are recommended with a bigger sample size whereby extended to other cohorts and without limiting to knowledge only but include the procedural skills as part of the assessment.

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Conflict of Interest

None.

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