

Original Article

Investigation of Nurses' Knowledge of Intramuscular Injections and Factors Affecting Injection Site Preference: A Case-Based Survey

Sinem Ozer Demir, RN, MSN

Sarıkamış State Hospital, Medical Department, 36000 Kars, Turkey

Arzu Karabag Aydin, RN, MSN, PhD

Assistant Professor, Kafkas University, Faculty of Health Sciences Department of Nursing, 36100 Kars, Turkey

Correspondence: Arzu Karabag Aydin, RN., MSN., PhD., Assistant. Prof, Kafkas University, Faculty of Health Sciences Department of Nursing, 36100 Kars, Turkey. E-mail: akarabag.aydin@gmail.com

Abstract

Aims: This study aimed to determine nurses' knowledge of intramuscular injection and the factors affecting injection site preferences.

Methods: A descriptive, cross-sectional study was conducted. This study was conducted in one state and one university hospital in the northeastern region of Turkey. The study sample comprised 233 nurses (68.5% of the total population).

Results: Participants had a mean case-based survey score of 55.93 ± 16.53 . Of the nurses who most recently completed an undergraduate nursing program, the highest number of correct answers were to questions concerning the dorsogluteal area as injection site and for identifying the ventrogluteal and deltoid sites, which was found to be statistically significantly higher than the other group / groups ($p < 0.05$).

Conclusions: Participants had lower scores than expected, indicating that they had little knowledge of intramuscular injection. Therefore, it is recommended that clinical nurses be provided with evidence-based in-service trainings on all intramuscular injection sites.

Keywords: Intramuscular injections, knowledge, nursing, evidence-based nursing

Introduction

Medication administration is one of the most common and basic nursing functions that is performed orally, locally, or parenterally (Engstrom et al. 2000, Gulnar & Ozveren 2016, Berman et al. 2016). Parenteral medication administration is that which is done by any means other than the gastrointestinal tract (DeLaune & Ladner 2011, Kaya & Pallos 2016). There are four commonly used routes of parenteral medication administration: intramuscular (IM), intravenous (IV), intradermal (ID), and subcutaneous (SC) (Nicoll & Hesby 2002, Berman et al. 2016). Medication management calls for the joint efforts of all healthcare professionals (DeLaune & Ladner 2011). Physicians are responsible for giving orders, pharmacists are responsible for supplying and dispensing medications within hospitals, and nurses are responsible for preparing and administering the medication as well as monitoring patients (Engstrom et al. 2000, DeLaune & Ladner 2011, Kaya & Pallos 2016). Nurses should possess expert knowledge in administering medication based on the principles of pharmacology and in decision-making through reasoning and evidence-based practice skills (DeLaune & Ladner, 2011). The World Health Organization (WHO, 2015) has reported that 16 billion injections are administered every year around the world and that 90% of them are administered intramuscularly. WHO has also called for a reduction in the number of unnecessary injections for the prevention of risks. The Agency for Healthcare Research and Quality (AHRQ) has stated that medication administration errors continue to be a serious patient safety problem, and as a result of 91 direct observation studies, medication administration errors continue to be observed at the rate of 8–25% (AHRQ, 2019).

Although there is much information about injections, preventable complications are still far too frequent (Mishra & Stringer 2010, Kim & Park 2014, Negi 2019). The most common complications in IM injection applications include pain, abscess, necrosis, contracture, hematoma, periostitis, infection, cellulitis, bleeding, and vascular, bone, and nerve injury (Nicoll & Hesby, 2002, Small, 2004, Mishra & Stringer 2010, DeLaune & Ladner, 2011, Kaya & Pallos, 2016). It is important that nurses choose the right injection site for a safe administration. The IM injection sites are dorsogluteal (DG) site, ventrogluteal (VG) site, deltoid muscle (DM), vastus lateralis (VL) muscle, and rectus femoris (RF) muscle (Rodger & King, 2000, DeLaune & Ladner, 2011, Hopkins & Arias, 2013, Berman et al., 2016, Kaya & Pallos, 2016). In the literature, the reasons nurses give for site preference include not knowing how to inject the area (Greenway, 2004), difficulty identifying the area anatomically (Wynaden et al. 2006), and difficulty identifying and using certain sites (Carter-Templeton & McCoy, 2008). The VG is recommended as the safest injection site. However, research shows that nurses clinically prefer the DG for injection delivery, which is still a more conventional method (Engstrom et al. 2000, Nicoll & Hesby 2002, Wynaden et al. 2006, Yapucu Gunes et al. 2009, Gulnar & Caliskan 2014, Kara et al. 2015, Ozturk et al. 2017). Few studies have reported results concerning nurses' knowledge of IM injection. There are more studies investigating nurses' knowledge of the DG and VG sites while their knowledge of other sites is understudied (Gulnar & Caliskan, 2014, Ammu et al. 2017, Sari et al. 2017, Gurol Arslan & Ozden, 2018, Su & Bekmezci 2020). When the results of these studies are examined, it is seen that the nurses' knowledge and application skills about IM injection are insufficient. In line with the results of the aforementioned studies, it can be said that many of the complications are caused by lack of knowledge and inappropriate techniques in IM injections. When the national and international literature is analyzed, no study investigating nurses' knowledge levels that included all sites for IM injection and reasons for site preference has been found. Based on this point, this study aimed to determine nurses' knowledge of all IM injection sites and the factors affecting their injection site preferences. This research is thought to complement this gap in the literature and pave the way for further research.

The research questions were as follows:

- A. Do nurses have sufficient knowledge of IM injections?
- B. Do nurses' demographic characteristics have an effect on their knowledge of IM injections?
- C. Do nurses' demographic characteristics have an effect on their injection site preference?

Methods

Aim(s): This study aimed to determine nurses' knowledge of all IM injection sites and the factors affecting their injection site preferences.

Study Design: This was a descriptive and cross-sectional study.

Population and Sample: The study was conducted in a city in TRA2 of the northeastern region of Turkey (TRA2: Agri, Kars, Ardahan, Iğdir). A pilot study was carried out in another state hospital (district hospital) of the city where 50 nurses worked. Ten of the 50 nurses included in the pilot study were not included in the sample. Then, the main study was carried out with 205 nurses of a state hospital and 135 nurses of a university hospital. The study population comprised a total of 340 nurses. No sampling was performed. Those who had administered IM injections before and voluntarily agreed to participate were recruited. The initial study sample comprised 164 nurses of the state hospital and 81 nurses of the university hospital. However, 12 nurses were excluded because they failed to complete the survey. Therefore, the final study sample consisted of 233 nurses (68.5% of the total population).

Data Collection Tools: Data were collected using a case-based survey (CBS) developed by the researchers based on the literature review. The CBS consisted of three parts.

The first part consisted of 14 questions on demographic characteristics (age, gender, level of education, etc.). In this study, 11 of the 14 questions were used for evaluation from the original form.

The second part consisted of 7 questions concerning the applications of nurses to determine on IM injection-site preference (what site or sites they were taught to administer IM injections, what methods

were used to teach them, and how well they knew about IM injection site detection, etc.). In this study, 3 of the 7 questions were used for evaluation from the original form.

The third part consisted of 7 case studies prepared to determine how well participants knew about IM injections in theory and in practice. There were 21 questions in total, 3 questions per case. Nursing interventions required by the cases were based on international standards. While preparing case questions, IM injection learning outcomes were firstly determined, after which questions containing each target behavior were created (Rodger & King, 2000, Nicoll & Hesby 2002, Small 2004, Greenway, 2004, Chan et al., 2006, Zaybak et al., 2007, Kara, 2011, Kaya et al., 2012, Kaya & Pallos, 2016).

Case 1: Mr. A. O., who is 60 years old, was referred to the neurology department due to severe dizziness two days ago. The physician ordered intramuscular administration of 2x50 mg of Dramamine; 1 ampoule of Dramamine is 1 ml and contains 50 mg of medication. The line drawn across the lower edge of the acromion process has two end points. There is a midpoint of the line drawn at the axilla level. By combining these three points, an inverted triangle is shown. The injection was made in the middle of this triangle.

Experts were consulted twice about the CBS. First, five nursing academics analyzed the survey in terms of formality, intelligibility, scientific content, and assessment criteria. The CBS was revised based on their feedback and presented to the second expert opinion. For the second expert opinion, apart from five experts who previously gave opinions, three specialists who were instructors in the department of fundamentals of nursing were consulted. The CBS was finalized based on the opinions and suggestions from the experts.

Data Collection: A pilot study was conducted on April 20, 2018 in the district hospital to determine the intelligibility of the survey. Ten nurses who agreed to participate in the pilot study were asked to complete the survey. Modifications were made to the CBS based on the pilot study results.

The main study data were collected between June 11 and September 10, 2018. For the implementation of the survey, the hours of the nurses' workload were determined. Nurses were asked to complete the survey in 20–30 minutes in the presence of the researcher, Researchers obtained the work schedules of the nurses whom had not been able to be contacted off the shift list and were able to schedule appointments for data collection at a convenient time for the nurses.

Ethical Considerations: The study was approved by the Ethics Committee of the Faculty of Medicine of X University (No: 80576354-050-99/179, Date: December 13, 2017). Written permission was obtained from the hospital management as well. Nurses were informed about the purpose, procedure, and confidentiality of the study prior to participation, and informed consent was obtained from those who agreed to participate.

Data Analysis: Data were analyzed using the IBM Statistical Package for Social Sciences (SPSS) for Windows Version 20.0 by researchers. Frequencies and percentages were calculated for demographic characteristics. Questions related to cases are coded as follows: "1" for each correct answer and "0" for each wrong answer. The CBS was scored out of 100, with each correct answer being worth 4.8 points (21 questions). The objective of this evaluation was to make statistical analyses and interpretation easier and more understandable. Whether the total correct answer scores obtained from the case questions of nurses showed a normal distribution according to independent variables was tested with the Kolmogorov–Smirnov (KS) test. The Kruskal–Wallis H and Mann–Whitney U tests, which are among non-parametric tests, were used in the analysis of non-normally distributed data. The value of $p < 0.05$ was accepted for the significance level of statistical tests.

Results

Table 1 shows the distribution of participants' correct answers to the CBS questions. They had a mean CBS score of 55.93 ± 16.53 (min: 24, max: 96). The nurses gave the most correct answers to questions one, three, and nineteen, while the gave the most incorrect answers to questions seven, twelve, and thirteen.

Table 1. Distribution of nurses' CBS correct answers (n=233)

Questions		Correct Answer n (%)	Wrong Answer n (%)
Mean of Total Correct Answers: 55.93±16.53 (min: 24, max: 96)			
CASE 1	1. The needle used in the injection to be applied to Mr. A. Ö. is 2.5 cm in length. According to this, how many degrees should the angle of needle entry be?	184 (79.0)	49 (21.0)
	2. Mr. A. Ö. what is the frequency of applying the ordered 2x75 mg Dramamine ampoule as IM?	121 (51.9)	112 (48.1)
	3. Which of the following are the IM injection sites of Mr. A. Ö. described by anatomical points?	183 (78.5)	50 (21.5)
CASE 2	4. Which of the IM injection sites and usage indication matches would be wrong for the nurse C. D.?	119 (51.1)	114 (48.9)
	5. At which injection site are complications such as abscess, hematoma, blood aspiration, and sciatic nerve injury common in IM injections?	143 (61.4)	90 (38.6)
	6. In the literature, is the rate of drug administration given correctly in order to reduce pain in IM injections?	130 (55.8)	103 (44.2)
CASE 3	7. Where was the injection of Mr. S. A. administered?	95 (40.8)	138 (59.2)
	8. How many ml of medicine will be administered to Mr. S. A. in a drug hour?	131 (56.2)	102 (43.8)
	9. Given the principles of safe drug administration, which one or more of the following is a valid reason for not administering the drug to Mr. S. A.?	148 (63.5)	85 (36.5)
CASE 4	10. The second injection of Mrs. Z. Ç. during the day 3 ml was administered 8 hours after the last drug. Accordingly, which security policy (s) were not considered?	132 (56.7)	101 (43.3)
	11. Of the following infection prevention principles, which (s) are considered correct when preparing and administering the medicine of Mr. Z. Ç.?	104 (44.6)	129 (55.4)
	12. What is the name of the site and muscle injected in Ms. Z. Ç.?	82 (35.2)	151 (64.8)
CASE 5	13. How many cm should the needle be used when applying IM injection to Mr. K. A.?	68 (29.2)	165 (70.8)
	14. Which (s) steps are correct for determining the site where you would administer an injection to Mr. K. A.?	127 (54.5)	106 (45.5)
	15. Which is the most suitable area for IM injection to Mr. K. A.?	107 (45.9)	126 (54.1)
CASE 6	16. Which of the following techniques is done to Mrs. H. D. as iron preparation IM?	154 (66.1)	79 (33.9)
	17. Which one or more of the following is the reason for choosing the technique used in the injection of Mrs. H. D.?	101 (43.3)	132 (56.7)
	18. Which of the following is one of the indicators for IM injection in Mrs. H. D. from the ventrogluteal site?	102 (43.8)	131 (56.2)
CASE 7	19. Which of the following complications developed due to IM injection in Mr. M. B.?	181 (77.7)	52 (22.3)
	20. Which of the following should not be done to reduce the pain associated with injection in Mr. M. B.?	144 (61.8)	89 (38.2)
	21. Which of the nursing practices should be done to reduce the anxiety of Mr. M. B.?	159 (68.2)	74 (31.8)

Table 2 shows the distribution of participants' correct answers based on demographic characteristics. Of the participants, 65.7% worked in the state hospital, 79.0% were women, 58.4% held an undergraduate degree (formal), 63.1% had 0–5 years of work experience, and 38.2% were internal medicine clinical nurses, while 27.9% were surgical clinical nurses. The mean age of participants was 27.49±5.82 years (min: 18, max: 52). Table 3 shows the distribution of participants' correct answers

based on some independent variables. Table 4 shows the distribution of knowledge-level correct answers for the IM injection according to the IM injection site preferences and the reasons for the site preference.

Table 5 shows the distribution of knowledge-level correct answer scores for IM injection according to the nurses' knowledge of determining the IM injection site. Table 6 shows the distribution of complications after IM injections. Thirty-eight participants observed at least one post-IM-injection complication such as pain (36.9%), muscle tissue damage (18.4%), infection (12.6%), nerve injury (9.7%), shock (5.8%), SC tissue damage (4.9%), and bone injury (4.9%).

Table 2. Distribution of nurses' correct answers based on demographic characteristics (n=233)

<u>Demographic characteristics</u>	<u>n (%)</u>	<u>Min-Max</u>	<u>Median (S.E.)[†]</u>	<u>p*</u>
Working institution				
State hospital	153 (65.7)	24.00-91.20	52.80 (1.290)	p=0.431
University hospital	80 (34.3)	24.00-96.00	57.60 (1.971)	Z:-0.788
Gender				
Female	184 (79.0)	24.00-96.00	57.60 (1.231)	p=0.494
Male	49 (21.0)	28.80-86.40	52.80 (2.280)	Z:-0.685
The most recently completed training program				
Health vocational high school	52 (22.3)	24.00-86.40	48.00 (1.961)	p=0.017
Pre-undergraduate	30 (12.9)	24.00-72.00	48.00 (2.450)	KW:12.037
Undergraduate (Formal)	136 (58.4)	24.00-96.00	62.40 (1.490)	
Undergraduate (Distance)	11 (4.7)	38.40-72.00	57.60 (4.032)	
Master / PhD	4 (1.7)	28.80-91.20	48.00 (13.200)	
Total working time in nursing				
0-5 years	147 (63.1)	24.00-96.00	57.60 (1.430)	p=0.823
6-10 years	44 (18.9)	24.00-91.20	55.20 (2.515)	KW:1.522
11-15 years	22 (9.4)	24.00-76.80	60.00 (3.299)	
16-20 years	10 (4.3)	38.40-72.00	50.40 (3.416)	
21 years or more	10 (4.3)	38.40-72.00	48.00 (3.450)	
Workplace				
Internal medicine clinic	89 (38.2)	24.00-96.00	57.60 (1.615)	p=0.580
Surgical clinic	65 (27.9)	24.00-91.20	52.80 (2.348)	KW:2.869
Emergency department	34 (14.6)	24.00-91.20	60.00 (2.818)	
Intensive care units	29 (12.4)	24.00-72.00	52.80 (2.664)	
Other	16 (6.9)	28.80-86.40	45.60 (4.400)	
Mean of age:	27.49±5.82 (min:18, max:52)			

† : S.E: Standard Error

* p<0.05

Table 3. Distribution of nurses' correct answers based on some independent variables (n=233)

<i>Independent variables</i>	<i>n (%)</i>	<i>Min-Max</i>	<i>Median (S.E)[†]</i>	<i>p*</i>
Competency of IM injection knowledge (n=233)				
Sufficient	181 (77.7)	24.00-96.00	57.60 (1.171)	p=0.385
Partly sufficient	52 (22.3)	24.00-91.20	52.80 (2.645)	Z:-0.385
Insufficient	0.00	0.00	0.00	
Competency of IM injection administration (n=233)				
Sufficient	188 (80.7)	24.00-96.00	55.20 (1.192)	p=0.746
Partly sufficient	43 (18.4)	24.00-91.20	57.60 (2.707)	KW:0.587
Insufficient	2 (0.9)	43.20-52.80	48.00 (4.800)	
Participation in the training program on IM injection after formal education (n=233)				
Yes	6 (2.6)	38.40-81.60	60.00 (7.504)	p=0.651
No	227 (97.4)	24.00-96.00	52.80 (1.096)	Z:-0.453
Information sources used in IM injection applications (n[‡]=484)				
Information received during nursing education				
Yes	224 (96.1)	24.00-96.00	55.20 (1.105)	p=0.178
No	9 (3.9)	28.80-72.00	43.20 (5.232)	Z:-1.347
Working together with experienced nurses				
Yes	91 (39.1)	24.00-91.20	48.00 (1.792)	p=0.032
No	142 (60.9)	24.00-96.00	60.00 (1.340)	Z:-2.148
Physicians' suggestions				
Yes	35 (15.0)	24.00-81.60	52.80 (2.397)	p=0.232
No	198 (85.0)	24.00-96.00	57.60 (1.199)	Z:-1.196
Journals and books on the subject				
Yes	50 (21.5)	24.00-96.00	67.20 (2.813)	p=0.022
No	183 (78.5)	24.00-91.20	52.80 (1.131)	Z:-2.292
Internet, newspaper, or television				
Yes	34 (14.6)	24.00-96.00	69.60 (3.414)	p=0.017
No	199 (85.4)	24.00-91.20	52.80 (1.109)	Z:-2.385
Agency policies and procedures				
Yes	48 (20.6)	24.00-91.20	57.60 (2.456)	p=0.219
No	185 (79.4)	24.00-96.00	52.80 (1.205)	Z:-1.229
Requested training on IM injection administration (n=233)				
Yes	140 (60.1)	24.00-96.00	57.60 (1.483)	p=0.107
No	93 (39.9)	24.00-86.40	52.80 (1.522)	Z:-1.610

†: S.E: Standard Error

* p<0.05

‡: n is folded.

Table 4. Distribution of knowledge level of nurses' correct answers for IM injection according to the nurses' IM injection site preferences and reasons for site preference

<i>Independent variables</i>	<i>n (%)</i>	<i>Min-Max</i>	<i>Median (S.E)[†]</i>	<i>p*</i>
The most frequently used site(s) for IM injection (n[‡]=374)				
Dorsogluteal (DG)				
Yes	180 (77.3)	24.00-91.20	52.80 (1.195)	0.013
No	53 (22.7)	24.00-96.00	62.40 (2.395)	Z:-2.475
Ventrogluteal (VG)				
Yes	58 (24.9)	24.00-96.00	57.60 (2.305)	0.222
No	175 (75.1)	24.00-91.20	52.80 (1.221)	Z:-1.222
Deltoid muscle (DM)				
Yes	48 (20.6)	24.00-91.20	48.00 (2.562)	0.104
No	185 (79.4)	24.00-96.00	57.60 (1.187)	Z:-1.626
Vastus lateralis (VL) muscle				
Yes	52 (22.3)	24.00-81.60	52.80 (2.046)	0.138
No	181 (77.7)	24.00-96.00	57.60 (1.259)	Z:-1.483
Rectus femoris (RF) muscle				
Yes	36 (15.5)	24.00-86.40	50.40 (3.005)	0.217
No	197 (84.5)	24.00-96.00	57.60 (1.155)	Z:-1.234
Reasons for choosing the most frequently used site (n[‡]=408)				
Safe area away from large blood vessels and nerves				
Yes	145 (62.2)	24.00-96.00	57.60 (1.406)	0.260
No	88 (37.8)	24.00-86.40	52.80 (1.681)	Z:-1.127
Being the recommended region during vocational education				
Yes	111 (47.6)	24.00-96.00	52.80 (1.589)	0.865
No	122 (52.4)	24.00-86.40	55.20 (1.485)	Z:-0.170
Site was specified by physician				
Yes	15 (6.4)	24.00-86.40	52.80 (4.415)	0.954
No	218 (93.6)	24.00-96.00	57.60 (1.119)	Z:-0.058
Determining the site is easy				
Yes	88 (37.8)	28.80-96.00	57.60 (1.687)	0.113
No	145 (62.2)	24.00-91.20	52.80 (1.398)	Z:-1.586
The patient's preferred region				
Yes	42 (18.0)	28.80-86.40	62.40 (2.447)	0.135
No	191 (82.0)	24.00-96.00	52.80 (1.203)	Z:-1.496

†: S.E: Standard Error

* p<0.05

‡: n is folded.

Table 5. Distribution of knowledge level of nurses' correct answers for IM injection according to nurses' knowledge for determining IM injection site (n=233)

<i>Independent variables</i>	<i>n (%)</i>	<i>Min-Max</i>	<i>Median (S.E)[†]</i>	<i>p*</i>
Knowledge for determining IM injection site				
Dorsogluteal (DG)				
I know	215 (92.3)	24.00-96.00	52.80 (1.111)	p=0.051
I don't know	18 (7.7)	24.00-91.20	67.20 (4.312)	Z:-1.953
Ventrogluteal (VG)				
I know	160 (68.7)	24.00-96.00	57.60 (1.264)	p=0.036
I don't know	73 (31.3)	24.00-91.20	48.00 (2.030)	Z:-2.093
Deltoid muscle (DM)				
I know	190 (81.5)	24.00-96.00	57.60 (1.189)	p=0.012
I don't know	43 (18.5)	24.00-86.40	48.00 (2.450)	Z:-2.520
Vastus lateralis (VL) muscle				
I know	159 (68.2)	24.00-96.00	52.80 (1.352)	p=0.639
I don't know	74 (31.8)	24.00-91.20	57.60 (1.794)	Z:-0.469
Rectus femoris (RF) muscle				
I know	148 (63.5)	24.00-96.00	57.60 (1.372)	p=0.760
I don't know	85 (36.5)	24.00-91.20	52.80 (1.771)	Z:-0.305

†: S.E: Standard Error * p<0.05

Discussion

Participants had a mean CBS score of 55.93 ± 16.53 (min: 24, max: 96), indicating that they had a lower level of knowledge of IM injections than desired. However, more than two-thirds of the participants stated that they knew enough about IM injections both in theory and in practice. Moreover, almost none of the participants had attended any IM injection training programs or read journals/books to keep themselves updated about IM injection interventions after completing their formal education. The low scores suggest that they do not keep themselves updated about IM injection in theory and practice, do not keep up with the literature, and use the DG site more often than the VG site on the misconception that they know enough about IM injections both in theory and in practice. Nurses should, therefore, keep their knowledge and skills up to date. As a result of the scientific developments and changes in health and nursing professional knowledge and practices, it is thought that nurses should keep their knowledge and skills current.

More than half of the participants correctly answered the questions (1, 6, and 20) concerning the learning outcome of "specifying the methods that relieve post-IM injection pain and discomfort." In the literature, the needle should be inserted at a 90-degree angle perpendicular to the body, and the insertion of the needle should be steady and smooth throughout the procedure to reduce post-IM injection pain and tissue damage. The rate of infusion should be adjusted (1 ml/10 sec) to prevent medication from leakage into SC tissue. The needle tip should be changed after the medication is prepared (Rodger & King 2000, Nicoll & Hesby 2002, Kaya & Pallos 2016). However, Mitchell and Whitney (2001) reported that IM injection at 1 ml/10 sec and 1 ml/30 sec did not make any difference in perceived pain. Post-injection massage is not recommended because it damages the tissues under the injection site (Kaya & Pallos 2016). In some studies, the correct response rates given by nurses to applications that will relieve pain and discomfort are similar to the rates in this study (Gulnar & Caliskan 2014). Gulnar and Caliskan (2014) reported that more than half of the nurses correctly answered the question concerning "the rate of

infusion” while two-thirds of them correctly answered the question concerning “post-injection massage.” In recent years, there has also been an increase in the number of studies addressing the methods that relieved post-IM-injection pain and discomfort (Kanika et al. 2011, Kant and Balci Akpınar 2017, Negi 2019, Thomas et al. 2019). The high number and variety of studies on this subject may be due to the high rate of patients complaining of pain after IM injection. The number of participants who correctly answered questions 12, 14, and 15 concerning the learning outcome of “correctly detecting the VG site based on anatomical signs” was lower than expected. In the literature, the VG injection site is regarded as the most reliable site because it is far from large blood vessels and nerves and has a much lower risk of injection-related errors than other sites (Mishra & Stringer 2010, DeLaune & Ladner 2011, Berman et al. 2016). Almost two-thirds of our participants stated that they knew how to detect the VG site; nevertheless, most of them stated that they used the DG site the most in this study. This result shows that nurses do not stay up-to-date with the latest developments in their field. Gulnar and Caliskan (2014) reported that most nurses incorrectly answered the questions concerning the VG site (detection, which age groups can be used, and what kind of medication can be used). Similar to this study’s results, researches show that nurses have limited and moderate knowledge of administering VG site injections (Altıok et al., 2007, Sari et al., 2017, Gurol Arslan & Ozden, 2018). Our results indicate that nurses think the VG site has a thinner SC tissue than the DG site, and therefore, fear unintentional injection to the bone, that patients do not accept VG injection because it is used less frequently, and that nurses have insufficient knowledge of the VG site, and thus prefer administering injections at the DG site much more than the VG site.

More than two-thirds of the participants correctly answered question 3 concerning “correctly detecting the DM site based on anatomical signs,” which was one of the three learning outcomes under “detecting the IM injection sites.” However, more than half of the participants incorrectly answered question 7 concerning the VL injection site as well as questions 12 and 15 concerning the VG injection site. These results can be accepted as an indication that the nurses’ anatomical knowledge is insufficient. Participants mostly answered the question concerning the DM

injection site correctly than other sites, probably because the DM is a small muscle and is in an easily accessible site. During nursing education, nurses should take anatomy lessons from faculty members who are experts in the field, and anatomy lecturers should explain their lessons in parallel with the current literature and evidence in nursing.

Most participants correctly answered questions 5 and 19 concerning the learning outcome of “identifying possible IM injection complications.” Choosing the wrong IM injection site and administering the injection using the wrong method and wrong equipment can cause serious complications such as pain, abscess, necrosis, contracture, hematoma, periostitis, infection, cellulite, bleeding, vascular, and bone and nerve injury (Nicoll & Hesby, 2002, Small, 2004, Mishra & Stringer, 2010, DeLaune & Ladner, 2011, Kaya & Pallos, 2016). DG injection site complications are mostly due to wrong injection techniques rather than inevitable risks (Boyd et al., 2013). Sanlıalp-Zeyrek and Kuzu-Kurban (2017) reported that nurses answered the statement “The VG site is far from sciatic nerves and vessels” more currently than the statement “The DG site is far from sciatic nerves and vessels.” Altıok et al. (2007) reported that most nurses correctly answered the statement “Possible IM site injection complications are abscess, infection, and rash.” In the same study, to the question “IM injection to what site can cause sciatic nerve injury?” two-thirds responded with the DG site. In this study, although most of the nurses stated that the risk of complications was high in the DG site after IM injection, the fact that they still use the DG site in their applications may indicate that the nurses performed the traditional method rather than a method based on evidence-based practice. Almost two-thirds of the participants correctly answered question 16 concerning the learning outcome of “being informed about the Z-track and air lock injection techniques,” indicating that they knew about medication administration techniques. However, less than half of them correctly answered question 17, suggesting that nurses do not know about the logical rationale behind injection techniques. However, nurses’ knowing the logical rationale by applying nursing theory to practice is one of the professional characteristics that shows the power of the knowledge of nursing (Ozluk & Sur, 2017). Sanlıalp-Zeyrek and Kuzu-Kurban (2017) reported that very few nurses correctly answered the question concerning the medications administered using the Z-track

injection technique while about half of them correctly answered the question concerning having the right knowledge and choosing the right intervention about the Z-track injection technique. In the literature, the Z-track and air lock injection techniques prevent medication leakage to SC tissue, and therefore, reduce pain and tissue trauma (Yapucu Gunes et al. 2009, Yilmaz et al. 2016, Soliman et al. 2018). IM injection using a conventional technique results in medication leakage to SC tissue whereas the Z-track injection technique delivers the full dose of medication to the patient (Yilmaz et al., 2016, Kaya & Pallos, 2016). Only one-third of the participants correctly answered question 13 concerning the learning outcome of “explaining the effective criteria for the selection of suitable tools and equipment for an IM injection site.” In the literature, choosing the appropriate needle size appears to be very important for the medication to reach muscle tissue (Nicoll & Hesby 2002, Wynaden et al., 2006, Diggle et al., 2006, Palma & Strohfus, 2013, Greenway, 2014, Larkin et al., 2017). Chan et al. (2006) radiologically examined DG site injections and reported that almost two-thirds of medication reached the SC tissue. Engstrom et al. (2000) stated that a needle too short in relation to body mass index (BMI) caused medication leakage into the SC tissue, resulting in such local side effects as tissue redness and swelling. In the study conducted by Zaybak et al. (2007), it was emphasized that as the BMI of the individuals increased, the SC tissue thickness increased and that the appropriate needle length should be chosen for the drug to reach the muscle. The needle length used for IM injection for adults varied between 25.4–50.8 mm (Kaya & Pallos 2016). In the case study conducted by Taylan Filinte et al. (2010), it was emphasized that the needle length should be longer than 3.8 cm, especially in persons with thick SC tissue. Although the majority of nurses knew the complications that would be caused by IM injection in questions 5 and 19 above, it is seen that one of the factors causing these complications did not occur due to the failure to select a needle of appropriate length. Almost half of the participants correctly answered question 2 concerning the learning outcome “explaining the expressions and symbols in a medication order,” question 4 concerning the learning outcome “counts the properties/indications for use of IM injection sites,” question 8 concerning the learning outcome “calculating the amount of medication for IM injection,” and question 10 concerning the

learning outcome “explaining the principles of safe medication administration.” In relation to these results, nurses are fundamentally and legally responsible for medication administration, which is an indispensable element of medical treatment (Cetinkaya Ulusoy et al., 2015). Nurses should abide by the six rights of safe medication administration (right of patient, right medication, right dose, right way, right time, and right documentation) in order to prevent medication errors (DeLaune & Ladner, 2011, Cetinkaya Ulusoy et al., 2015, Tosun, 2016). Half of the participants were unable to explain the expressions and symbols in a medication order, unable to specify the features and indications of IM injection sites, and unable to calculate the amount of medication for IM injection, indicating that they are not aware of their legal responsibilities and principles of safe medication administration. Less than half of the participants correctly answered question 11 concerning the learning outcome of “defining the principles of preventing possible IM injection infections.” There is little research on the principles of preventing possible IM injection infections (Altiook et al., 2007, Yapucu Gunes et al., 2009, Gulnar & Caliskan, 2014). However, there are numerous studies on nurses’ knowledge of nosocomial infections and nursing interventions for their prevention (Grigg et al., 2018, Eikelenboom-Boskamp et al., 2019). Yapucu Gunes et al. (2009) also reported that about one-third of nurses responded “always” to the statement “during IM injection, I change the needle after preparing the medication.” Gulnar and Caliskan (2014) reported that more than two-thirds of nurses correctly answered the statement “the VG injection site is more likely to become contaminated with feces.” while almost all of them correctly answered the statement “the 5 cm diameter of the injection site is wiped from inside out.” It is believed that administering IM injection, which is an invasive procedure, in accordance with the principles of surgical asepsis, will contribute to increasing patient safety by reducing the risk of infection in the patient. Participants stated that pain was the most frequent complaint in their patients after IM injection. Gulnar (2012) also reported tissue nodule and pain as the two most common complications observed in patients after IM injection. IM injections can cause serious complications such as pain, abscess, necrosis, and nerve injury (Nicoll & Hesby 2002, Small, 2004, Mishra & Stringer, 2010, DeLaune & Ladner 2011, Kaya & Pallos 2016). Avoiding pain is one

of the physiological needs, such as food, excretion, and sleep, which are at the lowest level of Maslow's hierarchy of needs (1940). Pain is an unpleasant feeling that reduces one's quality of life and prevents one from meeting other basic needs (Demir Dikmen, 2016). The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and pain management specialists consider pain the fifth vital sign (Cakircali, 2016). This can be considered as an indicator of how important pain has in human life.

Limitations: The results are specific to the nurses of only two hospitals, and therefore, can only be generalized to them.

Conclusion: Participants had a mean CBS score of 55.93 ± 16.53 , indicating that they have less knowledge of IM injections than desired. They stated that pain (36.9%) was the most frequent complaint in their patients after IM injection. As a result of this study, the following are suggested. In the IM injection practice lessons, instructors should focus on demonstrations aimed at improving students' psychomotor skills rather than only theoretical explanations. In-service training should be provided to nurses working in the clinic, including the dissemination of evidence-based research results for the use of all IM injection sites. Posters showing the advantages and disadvantages of injection sites should be prepared and hung in clinics to which nurses and other healthcare professionals can easily refer.

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