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Research article

Chest drains: prevalence of insertion and ICU nurses' knowledge of care

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ABSTRACT

Background: Even though literature revealed the problem of nurses' knowledge deficit regarding the care of chest drain in general, no study that investigated the prevalence of chest drains in ICUs and nurses' knowledge of chest drain among Jordanian nurses was found in the literature. This study aims were to describe the prevalence rate of chest drain insertion in Jordanian ICUs, and to evaluate Jordanian nurses' level of knowledge regarding chest drain care.

Methods: Anon-experimental descriptive design using cross-sectional survey was used for evaluating nurses' knowledge utilizing researchers-developed instrument. In addition, a retrospective chart review for patients who had chest drain in the previous three months to assess the prevalence rate of chest drain insertion. Data was analysis using the Statistical Package for Social Sciences (SPSS) program.

Results: The 3-month period prevalence of chest drain insertion was 8%. The most common indication for chest drains insertion was cardiac surgery (84.8%, $n = 134$) followed by pleural effusion (6.3%, $n = 10$). The results revealed that the mean score for nurses' knowledge regarding care of chest drain was 15.7 out of 30 (52.3%), with the majority had insufficient or intermediate level of knowledge (47.6%, $n = 107$ vs. 51.1%, $n = 115$). The areas with least level of knowledge were in the troubleshooting (31.9%), and removal (39.5%). Nurses from private hospitals had significantly higher ($M = 16$, $SD \pm 2.77$) level of knowledge ($F[2, 222] = 8.467$, $p < .001$) than nurses from other sectors.

Conclusions: Chest drain is prevalent in Jordanian ICUs, which requires nurses to know how to care for patients with this critical intervention. However, they seemed to lack the needed knowledge for the appropriate care. Developing, implementing and continuous monitoring of guidelines regarding chest drain care for nurses and physicians are recommended.

1. Introduction

The intensive care units (ICUs) provide care for the most complicated and critically ill patients. This care may involve using diagnostic or therapeutic invasive procedures, which may have many benefits on restoring patient's health condition. Although these procedures have life-saving assistance, patients are also exposed to many complications from these procedures or adverse events due to critical illness state [1]. Nurses in ICUs are the healthcare providers who play a vital role in handling and managing these invasive procedures; one of these procedures is chest drain insertion.

Chest drains are frequently inserted to patients with different conditions, and nurses frequently deal with them. According to the literature, Chest drains were needed for more than two million adults in the United States (US) for one year [2]. Among 893 patients in ICUs who required invasive procedures in one year, 150 (16.7%) had chest drain inserted [3]. Furthermore, In the United Kingdom (UK), during a six-month period in one hospital, there were 375 children who had an inserted chest drain [4]. Moreover, about 25% of all major trauma patients admitted to trauma centers in Australia needed chest drain [5].

Nurses have the responsibility of caring for patients with chest drain including assisting in insertion, managing, and removing chest drain. Nursing care of a patient with chest drain can be divided into two phases: pre-procedural and post-procedural. In the pre procedural phase, the nurse assembles equipment, puts the patient in the appropriate position, confirms the administration of analgesia and sedation provides the needed explanation of the procedure and obtains the informed consent.

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When drain is in place, the nurse should maintain under-water seal, record drain output, ensure adequate analgesia, care of the wound site and provide support and information to client and family [6]. When the aim for the insertion of chest drain is achieved, the drain is removed.

There are many complications for chest drain placement and removal. The rate of complications related to chest drain placement and management range from 5-35% [7, 8, 9]. The most serious one is tension pneumothorax, which may occur due to the obstruction of the drainage system or during removal [10]. Other complications include accidental removal or dislodgement of the tube and bleeding, all of which could pose a threat to patient's life, increase morbidity, and prolong treatment [11, 12].

To decrease the effect of such complications, nurses should be equipped with sufficient knowledge. However, literature revealed inappropriate levels of knowledge among nurses. For instance, a Nigerian study to measure the level of knowledge of care of chest drains among nurses working in different wards (ICU and medical surgical) in a teaching hospital revealed very poor knowledge of about 73.8% of the studied sample [13]. Also, a Turkish study revealed that approximately 44% of nurses had insufficient knowledge of chest drain care [14]. Magner et al. [15] reported that nurses had knowledge deficit of 22% concerning chest drain care, and another Irish study revealed poor knowledge among nursesof40% [16] with the lowest knowledge were noticed in the post-procedural care. For example, 85.5% of the nurses had poor knowledge on position of drainage system with relationship to waist level while mobilizing the patient, application of suction to chest drains 83% of the participant, daily changing of dressing over chest drain insertion site 72% of the nurses, and milking of tubes and drainage in a system with a dependent loop 41.1% of the nurses [13]. Magner et al [15] study revealed that 49% of nurses were uncertain regarding the correct positioning of chest drain tubing. However, most nurses 99.3% correctly answered questions regarding anatomy and the indication of chest drain [13].

Nurses needs an updated about knowledge of care for patients with chest drain, there are many resources, including; in-service education, libraries, conferences, workshop, university education and discussion among colleagues [15]. In an England descriptive study by Gerrish et al. [17] aimed to compare factors influencing the development of evidence-based practice revealed that, nurse depends heavily on personal experience and communication with colleagues rather than formal sources of knowledge. Furthermore, Manger and colleagues [15] revealed that most nurses refereeing to each other rather than formal sources to guide them for caring of chest drain, most nurses said the resources of updated information with chest drain care were mainly (62%) from conversation between colleagues.

In many clinical settings, healthcare providers especially nurses deal with patients with chest drain. Regardless of the prevalent use of the chest tube drain, it would seem insufficient knowledge and clinical guidelines deficiencies that give an ambiguity regarding practice [15]. Patient may be exposed to undesirable outcomes and delay treatment and recovery as well as increase length of hospitalization stay due to improper care of chest drain [18]. Incompetent nursing care of patient with chest drain may lead to undesirable outcomes on patients including life-threatening conditions and complications [19]. Further, anxiety and psychological burden may be exhibited on patients, and healthcare costs may be increased [20].

Even though literature revealed the problem of nurses' knowledge gaps regarding the care of chest drain [13, 15], studies that investigated the prevalence of chest drains in ICUs and nurse's knowledge of chest drain care are limited, with none was found in Jordan. Therefore, this study aimed to fill this gap by describing prevalence rate of chest drain insertion in Jordanian ICUs retrospectively during a 3-month period and evaluating Jordanian nurses' level of knowledge regarding chest drain care including the specific defects.

Research Questions

1) What is the prevalence rate of chest drain insertion in the ICUs in Jordanian hospitals over the period of three months?
2) What is the level of Jordanian ICU nurses' knowledge regarding the care of patients with chest drain?
3) Are there differences in nurses' knowledge of chest drain care based on their demographic characteristics?
4) What are the ways that nurses used to update themselves regarding the chest drain management?

2. Methods

2.1. Research design

Descriptive design using cross-sectional survey was used for examining nurses' knowledge. In addition, a retrospective review of the charts for patients' who had chest drain in the previous three months to assess the prevalence rate of chest drain insertion.

2.2. Setting

Each Jordanian hospital has an ICU. According to Jordan Ministry of Health (2019) [29], the number of hospitals in Jordan is 118. This study included two governmental, two private and one educational hospital, which were randomly selected. The eligible hospitals were written in pieces of paper and the researcher picked up randomly forms the group of hospitals. However, prevalence of chest drain insertion was assessed from three hospitals because these hospitals had a coding system for chest drain insertion and the other two had not.

2.3. Sampling

The sample of this study included nurses who were working in the ICUs of the selected hospitals from three healthcare sectors. A convenience sampling was used. The exclusion criteria for nurses include nurses' administrators and who had less than 6 months of experience. The prevalence rate of chest drain insertion for the three months period was computed by dividing the number of patients who had chest drain insertion over the past three months over the total number of patients admitted to the ICUs over the same period in the selected hospitals. Patients of less than 18 years were excluded from this study.

2.4. Instruments

This study utilized two instrument packages where Prevalence rate was estimated of patients who had chest drain inserted. Over three months, all admissions in the ICU were in the denominator and all those who had chest drain were in the numerator. For each patient with chest drain there was a data sheet to report some information related to the characteristics of patients and chest drains. The second instrument was consisted of three sections including demographics, how nurses keep themselves updated regarding chest drain care, and nurses' knowledge of care of chest drain.

The second instrument was developed by the researchers based on existing literature and presented to a panel of five experts to assist the content validity, two from academic area and three clinical nurses working in ICU. The following resources were used to develop the items of this instrument; Lippincott procedure (2016), Morton book for critical care nursing [21], EBESCO data base for articles related to chest drain including randomized clinical trial, observational and descriptive studies in addition to Magner [15] work, who established content validity for her tool through a panel of experts including cardiothoracic surgeons, anesthesiologists and senior nurses and reported a coefficient of 0.84 for test-retest and Cronbach's alpha score of 0.81. Moreover, the instrument of Magner was used by Lehwaldt and Timmins [16] in Ireland who also assured its content validity through panel of expert and stated an overall coefficient of 0.87.

Based on the literature review, the researchers developed a new tool that consist of 38 items to measure nurse's knowledge of chest drain care in compare to 50 items of the previous tool with a content validity index (CVI) The two panels member with clinical experts had master's degree in

critical care nursing, and the other had bachelor's degree in nursing who is the head nurse in surgical ICU and the other two experts were from academic field of nursing with a doctoral degree in nursing.

Those experts were asked to rate the agreement for each item based on Yaghmaei [22] for this instrument. Then CVI were calculated, and the item which had a score of above 0.90 was included in the questionnaire. The final version of the instrument contained 30 items with a CVI of greater than 0.90. The 30 items were classified into six main areas including, insertion (4 items), complications (5 items), direct care (9 items), fluctuation and bubbling (5 items), troubleshooting (5 items) and removal subscale (2 items).

Regarding the scoring system of nurses' knowledge, the researcher classified level of knowledge into three main categories: (1) poor (insufficient) below 50% (<15/30) of the correct answer, (2) intermediate 50%–75% (15–22.5/30) and (3) sufficient knowledge more than 75% (>22.5/30).

2.5. Ethical considerations and data collection procedure

The IRB approval was obtained from the Scientific Research Committee at The School of Nursing-The University of Jordan and from the ethical committees of the selected hospitals. Data was collected over 3 months, from the first of March 2017 to the end of May 2017.

Regarding the period prevalence of chest drain insertion in the ICUs, the researcher approached the patients' charts to estimate the number of patients who had chest drain inserted during the last three months from the beginning date of this study, simultaneously all number of patients who were admitted to the same ICUs during the last three months were gathered by the researcher himself through retrieving the patients' records. The process of prevalence data collection was based on the codes for chest drain in the hospitals. This code means that chest drain procedure for patient had a specific number for the statisticians in each hospital. The study period for collecting data included three months retrospectively, from the beginning of December 2016 until the end of February 2017. The researcher started data collection for prevalence and chart review for patients on the first of March 2017 and finished on fifteen of April 2017.

2.6. Data analysis

All data were analyzed using the Statistical Package of Social Science (SPSS, Chicago, IL, USA) version 21.0. Descriptive statistics were conducted to estimate prevalence rate and describe the study sample. Furthermore, independent t test and one way analysis of variance (ANOVA) tests were used to compare between means of knowledge score. Pearson Correlation Coefficient test was used to examine the relationship of knowledge with continuous demographic variables (age and year of experience).

3. Results

3.1. Prevalence of chest drain insertion

The results of chart review for patients' files revealed that among 1973 ICU files (1013 from governmental hospital and 960 from private hospitals), 158 patients had chest drain inserted. This means that the 3-month period prevalence of chest drain insertion was 8% in overall hospitals, whereas the prevalence was the highest in the governmental hospital with a rate of 10% and the lowest in the second private hospital with a rate of 3.3%. Table 1 represents the 3-month prevalence rate of each individual hospital.

Regarding the characteristics of patients and chest drains, the majority of patients were male (75.3%, $n = 119$) and the mean age was 56.85 years ($SD \pm 13.18$). The most common indication for chest drains insertion was cardiac surgery (84.8%, $n = 134$) followed by pleural effusion (6.3%, $n = 10$). There was a variation between patients with a minimum of one to a maximum of three chest drains for each patient, with a mean score of 1.87 ($SD \pm 0.68$). The mean score of the duration of chest drain stay was 4.14 days ($SD \pm 2.85$). The majority of chest drains (65.8%, $n = 104$) were inserted for patients in both the pericardial area and pleural cavity. Additionally, the majority of patients were diagnosed with coronary artery disease (CAD) (74.05%, $n = 117$) and underwent surgery (86.1%, $n = 136$). Table 2 shows the demographics of patients who had chest drain inserted.

3.2. Nurses' knowledge of chest drain care

3.2.1. Nurses' socio-demographic variables

The response rate was 83%, where 270 questionnaires were distributed to nurses and 225 were filled and retuned. The mean age for nurses was 28.66 years ($SD \pm 5.4$) and their mean years of experience in nursing and in ICU were 5.94 years ($SD = 4.79$) and 4.28 years ($SD \pm 3.84$), respectively. Over half of the nurses were male 52.9% ($n = 119$), and the majority had a bachelor's degree in nursing 90.2% ($n = 203$). Nurses form the governmental and private hospitals represented 36.4% ($n = 82$) and 36.4% ($n = 82$) of the sample, respectively. Finally, the majority of nurses were working in mixed ICUs 61.3% ($n = 138$). Table 3 illustrates these demographics of nurses.

3.2.2. Level of nurses' knowledge regarding care of chest drain

The results revealed that the mean score for nurses' knowledge regarding care of chest drain was 15.7 out of 30 (52.3%) with a range between 5-23. Furthermore, the results showed that 47.6% ($n = 107$) of the participants were classified as having insufficient level of knowledge regarding care of chest drain, 51.1% ($n = 115$) had intermediate level of knowledge, and only 1.3% (n = 3) classified as having sufficient knowledge. Table 4 containing the level of ICU nurses' knowledge according to the classification established by the researchers revealed that nurses had more knowledge in direct care area (67.5%) followed by complication area (54.3%). On the other hand, the areas with least level of knowledge were in the troubleshooting (31.9%), and removal (39.5%). At individual items (Table 5), questions number 16 *"chest tube should be below the patients' chest level"*, 14 *"encouragement of patient to ambulate to cough and to have deep breathing exercise to promote healing"* and 8 *"minimizing pain through support incision site while coughing and sitting upright"* had the highest correct answers (87.6%, 85.3%,80.4%, respectively), while questions number 26 *"milking and striping used to remove clot, to prevent occlusion of the tube"*, 22 *"fluctuation increased during mechanical ventilation if the patient with chest drain inspired"* and 24 *"The nurse*

Table 1. The 3-month period prevalence of chest drain insertion in the three hospitals.

Healthcare Sector	Admissions to ICU*	Patients needed Chest Drain**	Period Prevalence %
Governmental	1013	101	10
Private 1	480	41	8.5
Private 2	480	16	3.3
Total	1973	158	8

* All patients admitted to the participating ICUs form December 2016 to February 2017.
** Number of patients for whom chest drain was inserted during the same 3-month period.

Table 2. Characteristics of Patients who had Chest Drain Inserted (N = 158).

Variable	n (%)	M (SD)
Age		56.85 (13.18)
Number of chest drain		1.87 (0.68)
Duration of chest drain		4.14 (2.85)
Type of hospital		
Governmental	101 (63.9)	
Private	57 (36.1)	
Gender		
Male	119 (75.3)	
Female	39 (24.7)	
Indication for chest drain		
Pneumothorax	7 (4.4)	
Hemothorax	3 (1.9)	
Hemopneumothorax	2 (1.3)	
Cardiac surgery	134 (84.8)	
Pleural effusion	10 (6.3)	
Emphysema	2 (1.3)	
Case		
Trauma	5 (3.2)	
Medical	17 (10.8)	
Surgical	136 (86.1)	
Diagnosis		
Cardiac disorders	138 (87.35)	
Respiratory disorders	11 (6.9)	
Trauma	4 (2.6)	
Others	5 (3.15)	
Site of chest drain		
Pleural cavity	23 (14.6)	
Pericardial	30 (19)	
Both	104 (65.8)	

Table 3. Nurses' demographic characteristics (N = 225).

Variable	n (%)	M (SD)
Age		28.66 (5.40)
Years of experience		5.94 (4.79)
Years of experience in ICU		4.28 (3.84)
Type of hospital		
Governmental	82 (36.4)	
Educational	61 (27.1)	
Private	82 (36.4)	
Gender		
Male	119 (52.9)	
Female	106 (47.1)	
Educational level		
Bachelor	203 (90.2)	
Master's degree	22 (9.8)	
Area of practice		
Medical ICU	23 (10.2)	
Surgical ICU	31 (13.8)	
Coronary ICU	25 (11.1)	
Mixed ICU	138 (61.3)	
Post cardiac surgery unit	8 (3.6)	
Guideline's presence in unit		
Yes	158 (70.2)	
No	67 (29.8)	
Perceived knowledge		
Poor	18 (8)	
Good	180 (80)	
Excellent	27 (12)	
Frequency of care with chest drain		
Every working day	45 (20)	
Nearly every working day	43 (19.1)	
Once a week	59 (26.2)	
Once every month	37 (16.2)	
Once every two months	26 (11.6)	
Once a year	7 (3.1)	
Never	8 (3.6)	

should immediately notify the physician after chest drain tube disconnected" had the lowest scores (16.4%, 16.9%, 16.9%, respectively).

3.2.3. Nurses' knowledge based on their demographics

None of the demographic variables had statistically significant difference of knowledge mean score except the type of hospital, where nurses from private hospitals had significantly higher level of knowledge ($M = 16$, $SD \pm 2.77$) ($F[2, 222] = 8.467$, $p <= .000$) than nurses in governmental hospital (M = 15.10, SD ± 2.99) and educational hospital ($M = 15.14$, $SD \pm 2.71$).

3.3. Resources for nurses to keep updated knowledge regarding chest drain care

Descriptive statistics (Table 6) were used for the purpose of describing resources that nurses used to keep themselves updated in chest drain care. The results revealed that *"discussion with colleagues"* was the most commonly reported resource (54.2%, $n = 122$) which may not be considered as evidence resource, followed by*"In-service education"*(41.8%, $n = 94$). On the other hand, *"nursing journals"* was the least source (5.8%, $n = 13$). The majority of nurses reported having no access to nursing library to study about chest drain care (46.2 %, $n = 104$) followed by their hospital library (24%, $n = 54$).

4. Discussion

4.1. Prevalence of chest drain insertion

Based on the researchers' knowledge, this is the first study in Jordan that assessed the period prevalence of chest drain insertion in ICUs. Also, no studies have been found worldwide to specifically assess the period prevalence of chest drain in ICUs. However, some information regarding the numbers of chest drain was found embedded in some studies, and most of them were in all hospital units. The results of this study showed that the 3-month period prevalence in Jordanian ICUs was 8% (158/1973), which could be considered high. Concerning the studies that have been found worldwide, Bruce and colleagues [4] revealed that 375 patients during six months had been inserted with chest drain in the whole hospital. Also, Pottier et al [3] reported that 150 patients had chest drain inserted among 893 ICU patients who required invasive procedures in a period of one year. Cunningham et al. [23] revealed that 462 patients were found with chest drain in a period of 10 years in a study to assess the best practice either to perform chest x ray after chest drain removal or not with exclusion of cardiac patients. These relatively high numbers give clues to the healthcare stakeholders including nursing administrators to focus on this concern in order to prepare knowledgeable and qualified nurses to appropriately deal with chest drain, thus reducing morbidity and mortality rates, and improving the quality of patient outcomes [24].

Regarding the chart review for the chest drains inserted to the patients, no studies have been found in Jordan and worldwide to describe the characteristics of those patients and chest drains. In our study, heart diseases such as coronary artery diseases and valvular diseases were the most common indication for chest drain insertion with a percentage of 87.35%. The insertion of chest drains for patients may be related to the open-heart surgeries that were performed for most of patients in this study.

4.2. Nurses' knowledge of chest drain care

Although the 3-months period prevalence was relatively high (8%) in Jordanian ICUs, nurses' knowledge was insufficient regarding chest drain care. This problem could expose patients to more complications and inappropriate care. No studies have been conducted in Jordan to assess nurses' knowledge about chest drain care. However, some studies were found worldwide to study this concern and they focused on general nurses. The current study revealed that the majority of ICU nurses had intermediate level of knowledge regarding care of chest drain and near the half of participants had insufficient knowledge (47.6%), with no difference in knowledge level based on their characteristics except for the type of hospital, where nurses in private hospitals had higher level of knowledge. The higher level of knowledge in private hospitals compared to other hospitals may be related to more available resources for nurses in private hospitals. For instances, the active in-service education and the international accreditation as well as the institutional embrace of research and evidence-based practice in the private hospitals (Personal inquires). The results of this study were congruent with some of the worldwide studies that were found concerning this issue. For instance, a study conducted in Turkey revealed that 44.4% of nurses had insufficient knowledge regarding chest drain care [14]. Another study conducted in Nigeria demonstrated more deficits in nurses' knowledge 78.3% concerning chest drain care [13].

On the other hand, the results were inconsistent with Magner et al. [15] who reported that 88% of nurses had sufficient knowledge of chest drain care. The higher level of nurses' knowledge in Ireland may be due to the available resources as a developed country with well-established guidelines, whereas the other mentioned studies including our study were conducted in developing countries that are known to have fewer resources.

Regarding the specific items in this study, the majority of nurses had insufficient knowledge regarding the using of milking and stripping of the chest tube as a way to remove clot and thus prevent occlusion. In a study conducted in Turkey to assess nurses' knowledge of chest drain care, revealed that above half of the nurses incorrectly answered the use of stripping and milking 53.6% [14]. Furthermore, Lehwald and Timmins [25] for the same expression showed that nurses reported inadequate knowledge regarding milking and stripping of chest tube with 29% of the participants, as well as in the Magner et al. [15] with 14.1% of the participants. This method is unsafe and may increase intrapleural pressure, thus increasing the risk of tension pneumothorax, bleeding and pain which may deteriorate the health condition [26]. So, it is not a recommended method to remove clots from chest tube. However, Shalli et al. [27] reported that 74% of surgeons favored stripping as a way to remove clot from chest tube, while 71% of nurses said that this method is not allowed. These differences and inconsistencies between surgeons and nurses regarding this concern emphasize the need to create clear and robust guidelines regarding this issue to practice it in safe way and prevent patients' complications.

Tarhan et al. [14] reported that the majority of nurses (78.4%) had sufficient knowledge about caring of chest drain bottle to be below the patient's chest level. This was consistent with the current study and Magner et al. [15] who revealed that 98.3% of nurses correctly answered this expression. Furthermore, 85.5% of nurses had sufficient knowledge regarding this issue in a study conducted in Nigeria [13]. Chest drain bottle must be under the chest level of patient to prevent discharge from entering to the pleural space that may inhibit breathing, and it seems that most of the nurses understood this point of care.

Clamping of chest tube during patients transportation or at all is discouraged due to the possibility of building up pressure inside the tube that may increase the pressure inside the pleural cavity, thus increasing the risk of tension pneumothorax [28]. Our results indicated that 77.3% of the participants knew that clamping of chest tube is a method to prevent disconnection during patients' transportation. This was consistent with Lehwaldt and Timmins [25], Tarhan et al. [14] and Magner et al. [15] who revealed that nurses falsely answered this item with 75.1%, 58.2% and 40%, respectively. Clamping of chest drain must be performed only in two situations; accidental disconnection of the tubes and during the change of the chest drain bottle and the clamping time should be restricted to less than 1 min [10].

4.3. Nurses' resources regarding knowledge of chest drain care

Discussion with colleagues was the most resource for ICU nurses to keep themselves updated regarding chest drain care, which is considered unreliable source of knowledge. This resource of knowledge may be one of the reasons behind the insufficient knowledge. This was consistent with other studies that revealed discussion with colleagues to be the main resource for nurses to update their knowledge regarding chest drain care [14, 15]. This result highlights the need for innovative methods that are evidence based rather than conventional for nurses to update their knowledge regarding this concern. Such methods include nursing journals, valid and reliable internet websites as well as foster in-service education in the healthcare institutions and academic areas.

4.4. Recommendations

The results of this study regarding prevalence of chest drain insertion can be used as a base line data for healthcare professions to pay more attention, to this critical issue. Hospitals should adopt a record system for all patients' procedures including chest drain to facilitate the measurement of prevalence rate, because some hospitals had no record system. The inadequate nurses' knowledge regarding chest drain care should motivate healthcare professionals for ongoing training and educational programs regarding this issue to improve nurses' knowledge. Continuous education departments should enhance the in-service education and monitor the continuity of these programs among nurses on their working areas. Also, the hospitals should adopt new and updated technologies to obtain knowledge such as subscription with trusted international journals and facilitate nurses' access to these websites. This will help nurses to gain evidence based and updated data regarding chest drain care and other health issues.

Developing of clear evidence -based guideline about caring of chest drain is very important to guide nurses. Also, nursing schools may have a major role through integrating this topic in the curricula and focusing on

Table 4. Classification with items and the mean sore of nurses' knowledge regarding chest drain care.

Category	Items	Knowledge mean score
Insertion	1, 2, 3, 4	52.5%
Complications	5, 6, 7, 8, 9	54.3%
Care (Dressing and suction)	10, 11, 12, 13, 14, 15, 16, 17, 18	67.5%
Fluctuation	19, 20, 21, 22, 23	48.7%
Troubleshooting	24, 25, 26, 27, 28	31.9%
Removal	29, 30	39.5%

Table 5. Percentages of correct answers regarding nurses knowledge of chest drain care (N = 225).

No	Item	n (%)	Rank
1.	Chest drain may be inserted in the 2nd or 6th intercostal space, as well as in the mediastinal area.	158 (70.2%)	9
2.	Chest drain is inserted in the 6th intercostal space to withdraw air, and in the 2nd intercostal space for fluid removal.	108 (48%)	14
3.	Indications for chest drain include pneumothorax and hemothorax only.	118 (52.4%)	13
4.	Chest radiography can be performed to confirm the proper position of chest tube with no need for lung auscultation.	89 (39.6%)	19
5.	In addition to hand washing and wearing gloves and gown, there is a need to wear a cap, goggles, and mask for the preventing infection while caring for a chest drain.	142 (63.1%)	11
6.	Sterile technique should be used during changing the system of chest drain, but not need during manipulating the connections.	85 (37.8%)	20
7.	Narcotics are not recommended regularly for a patient with chest drain due to a possibility of shortness of breath.	98 (43.6%)	17
8.	To minimize chest, drain related pain, nurse should instruct the patient to sit upright (Semi-Fowler) and support the incision site while coughing.	181 (80.4%)	3
9.	Complications related to chest drain care are few and have minimal impact on patient outcome.	105 (46.7%)	15
10.	The nurse should check the dressing of chest drain at least once every 8 h.	175 (77.8%)	5
11.	The nurse may use either dry gauze or petroleum saturated gauze for chest drain dressing.	59 (26.2%)	22
12.	The chest drain dressing should be changed according to hospital policy, or as needed if soiled or loose, but not every day.	164 (72.9%)	8
13.	Using frequent suctioning in chest drainage system is effective than minimal use or no suction at all.	97 (43.1%)	18
14.	Patients with chest drain instructed to ambulate, encouraged to cough, and have deep breathing exercise.	192 (85.3%)	2
15.	Chest drain tube should be checked to be unclamped and without kinks (twisting) or dependent loop.	177 (78.7%)	4
16.	Chest drainage system should be below the patient chest level	197 (87.6%)	1
17.	At least, chest drain output should be assessed once every 2 h for amount and color.	158 (70.2%)	9
18.	Patient should be positioned lateral supine for air drainage, or supine with bed elevated 30 degree for fluid drainage.	148 (65.8%)	10
19.	The absence of respiratory fluctuation in the underwater-seal chamber can indicate the lung has re-expanded.	99 (44%)	16
20.	The absence of respiratory fluctuation in the underwater –seal chamber can indicate an obstruction in the system.	168 (74.7%)	7
21.	During respiration, fluctuation in underwater-seal chamber occurs due to pressure change in the pleural cavity.	171 (76%)	6
22.	If patient is on mechanical ventilator, fluctuation of the underwater seal increases during inspiration and decreases during expiration.	38 (16.9%)	26
23.	Intermittent bubbling in the underwater-seal chamber always means that the system is removing air from the pleural cavity.	72 (32%)	21
24.	The nurse should immediately notify the physician after chest drain tube disconnected.	38 (16.9%)	26
25.	The tube of chest drain system should be clamped when transporting the patient to prevent disconnections.	51 (22.7%)	24
26.	Milking or stripping is used to remove the clot from the chest drain tube, which prevents occlusion.	37 (16.4%)	27
27.	If the drainage system knocked (strike down), a new drainage system should be replaced.	56 (24.9%)	23
28.	When replacing new drainage system, cross-clamp of the chest tube stops air from entering or exiting.	177 (78.7%)	4
29.	Chest drain is removed at the end of exhalation or at end of inspiration.	137 (60.9%)	12
30.	Immediately after chest tube removal, the nurse should measure vital signs and then apply sterile dressing over the site.	41 (18.2%)	25

undergraduate nursing students to educate them about chest drain care. Another future studies with different designs such as observational and interventional studies are needed to explore this issue, with larger sample size to increase the representativeness and generalizability of results.

Table 6. Resources to keep nurses update concerning chest drain care (N = 255).

Resource	n (%)
Available resources	
In-service education	94 (41.8)
Study days	19 (8.4)
Nursing journals	13 (5.8)
Guidelines	38 (16.9)
Related books	18 (8)
Others	4 (1.8)
None	39 (17.3)
Additional resources	
Conference	43 (19.1)
Discussion with colleagues	122 (54.2)
Workshops/seminars	45 (20)
Others	15 (6.7)
Nursing library	
Your own hospital	54 (24)
Another hospital	20 (8.9)
At college/library	47 (20.9)
No access	104 (46.2)

Also, nurses' compliance with practice guidelines may be studied to assure the implementation of nurses' knowledge concerning this issue. Furthermore, implementing and continuous monitoring of guidelines regarding chest drain care for nurses and physicians are recommended.

4.5. Limitations and strengths

Recruiting the sample from hospitals from only one city in Amman constitutes a limitation that may limit the generalizability of the results. The convenience sampling technique was used to approach ICU nurses, which may have possibility of bias. On the other hand, this was the first study that had been conducted in Jordan that gives strength to our study and contributes to the body of knowledge. All studies that have been found concerning this topic were conducted in one single hospital and they focused on general nurses in hospital, whereas this study was conducted in ICUs rather than general departments in three different healthcare sectors (five hospitals for nurses' knowledge and three for the prevalence of chest drain insertion).

4.6. Conclusion

This study was the first one in Jordan that assessed the prevalence of chest drain insertion in ICU as well as the nurses' knowledge of chest drain care. The results revealed that the 3-month period prevalence was 8%, and the majority of ICU nurses had insufficient knowledge regarding care of chest drain. Discussion with colleagues was the predominant resource for nurses to obtain knowledge regarding chest drain care. This unreliable resource should be discouraged due to the possibility of harm on patients'

outcome, thus educators in healthcare institutions can use another reliable resources and method to train nurses regarding chest drain care such as international journals, trustworthy internet websites and continuous in-service education.

Declarations

Author contribution statement

Jamal A.S. Qaddumi and Muhammad W. Darawad: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Ashraf Abuejheisheh: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

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Data included in article/supplementary material/referenced in article.

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The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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