Nurses’ knowledge and understanding of obstacles encountered them when administering resuscitation medications: a cross-sectional study from Palestine

Rawan I. Qedan1, Marah A. Daibes1, Samah W. Al-Jabi1, Amer A. Koni1,2 and Sa’ed H. Zyoud1,3,4*

Abstract

Background: Medication errors (ME) are one of the most important reasons for patient morbidity and mortality, but insufficient drug knowledge among nurses is considered a major factor in drug administration errors. Furthermore, the complex and stressful systems surrounding resuscitation events increase nursing errors.

Aims: This study aimed to assess the knowledge about resuscitation medications and understand the obstacles faced by nurses when giving resuscitation medications. Additionally, errors in the reporting of resuscitation medication administration and the reasons that prevented nurses from reporting errors were investigated.

Methods: A cross-sectional study was conducted in the West Bank, Palestine. Convenient sampling was used to collect data, which was collected via a face-to-face interview questionnaire taken from a previous study. The questionnaire consisted of five parts: demographic data, knowledge of resuscitation medications (20 true/false questions), self-evaluation and causes behind not reporting ME, with suggestions to decrease ME.

Results: A total of 200 nurses participated in the study. Nurses were found to have insufficient knowledge about resuscitation medications (58.6%). A high knowledge score was associated with male nurses, those working in the general ward, the cardiac care unit (CCU), the intensive care unit (ICU) and the general ward. The main obstacles nurses faced when administering resuscitation medication were the chaotic environment in cardiopulmonary resuscitation (62%), the unavailability of pharmacists for a whole day (61%), and different medications that look alike in the packaging (61%). Most nurses (70.5%) hoped to gain additional training. In our study, we found no compatibility in the definition of ME between nurses and hospitals (43.5%).

Conclusions: Nurses had insufficient knowledge of resuscitation medications. One of the obstacles nurses faced was that pharmacists should appropriately arrange medications, and nurses wanted continuous learning and additional training about resuscitation medications to decrease ME.

Keywords: Knowledge, Resuscitation medications, Medication errors, Nurses, Palestine, Cross-sectional

Background

One of the most important reasons for patient morbidity and mortality is medication errors (ME) [1]; furthermore, it is thought to be the most important cause of preventable harm to patients [2]. ME are a dangerous problem during treatment, especially for patients in...
intensive care units (ICUs) who can suffer very serious complications due to their severe illnesses and the complex pharmacotherapy programs they receive [3].

Any errors in dose, administration rate, drug concentration, type of drug, route of administration, method of administration or delay in administration, fall under the definition of ‘ME’ [4]. Research has found that there can be important errors during the preparation and administration of medications [4–6]. There are many causes of EM, and many research studies have focused on these reasons; their findings include stressful and complex systems, workload, poor skill, distracting nurses during their work, lack of concentration, and insufficient knowledge of drug and calculation tasks, confusion between similar and sound-alike medications, use of medications with a narrow therapeutic index (NTI), and insufficient experience in nurses’ work [4, 5, 7–10]. Furthermore, other research has found that serious incidents occur due to problems related to teamwork and knowledge related to cardiac arrest in special cases [11].

In general, the prevalence of ME was 32.1% [12] to 94% [13]. Importantly, approximately 38% of ME are caused by nurses [14]. The prevalence of ME among hospital nurses was 17% [15], while it was 39.68% among nursing students [16], and both percentages are considered high. Furthermore, a systematic review found a prevalence between 16–27% [17]. In countries in the Middle East, studies related to ME are few and do not contain sufficient information [18]. A Jordanian analysis demonstrated that the size of the hospital may play a role in the nursing rate of reporting ME and their views on this regard [19]. In the same country, lack of experience and knowledge, along with workload, was documented as the main factors behind medication error [20]. Furthermore, a retrospective study in a teaching hospital showed that 14.3% of incidents are related to ME [21]. In another Middle East country, Saudi Arabia, medication errors were found to be high in a hospital during the COVID-19 crisis as 19% [22]. Researchers explain that due to work overload among healthcare providers [22].

Unfortunately, many hospitals do not have a special form or internal system for reporting errors [23], and sometimes, health care professionals tend to report errors voluntarily and using verbal methods instead of a written or documented report [23, 24]. This led to under-reporting of ME, which are estimated to be 50–60% each year [23]. Different ways of reporting errors were identified, including verbal and written on a paper [25], and the most recent one is web-based forms [26]. The consequences of ME on healthcare professionals include producing further training, improving communication, and informing the personnel who committed the error [27].

Resuscitation is a multipart process executed in a short time, frequently occurring in uncontrolled situations; a stressful situation that requires nurses with high knowledge, and where, with limited information and time nurses, should respond as fast as possible. In such conditions, nurses’ performance may not be satisfactory enough, particularly when nurses are not qualified or experienced enough to respond to stressful conditions [11, 28]. Confidentiality in the resuscitation environment can generate errors in the critical stages of medication administration [29].

Nurses lacking knowledge of drugs and their appropriate doses can cause medication errors [3, 30], especially with increased stress and interruptions during medication administration among nurses [31]. The resuscitation procedure requires a rapid response of nurses to the doctor’s oral orders without enough time to get reference information on administering a resuscitation medication [32].

In addition, previous research worldwide has produced few studies on nurses’ knowledge of resuscitation medications and their obstacles during medication administration. This study is considered to be the first in Palestine. To reduce morbidity and mortality among patients with ME [33], it is necessary to assess the pharmacological knowledge and to understand the obstacles they face when administering resuscitation medications. Nursing associations can then argue for mandatory training courses on administering resuscitation medications and decreasing the obstacles they encounter to minimise resuscitation ME as much as possible. This research will help university academics design multidisciplinary courses in clinical pharmacology focusing on resuscitation medication as part of ongoing nurse education that meets the needs of Palestinian nursing practice situations.

The administration of medication during resuscitation must be performed correctly, as incorrect or delayed drug administration can result in serious harm or death to patients. Therefore, the study objectives were: 1) to assess nurses’ knowledge about resuscitation medications, 2) to determine the obstacles that nurses face when giving resuscitation medications, 3) to evaluate resuscitation medication administration errors in reporting and the reason that prevent nurses to not report the errors, and 4) to determine factors that affect sufficient knowledge among nurses.

**Methods**

**Study design**

We used a cross-sectional design, which is an observational method applied to assess knowledge among health members at a specific point in time [34, 35]. In fact, we
evaluated the knowledge and understanding of nurses about the obstacles they face when administering resuscitation medications.

Study setting
Palestine consists of two zones: the West Bank and the Gaza Strip, with a total population of about five million inhabitants. Nearly 60.2% live in the West Bank and 39.8% live in the Gaza Strip. The West Bank is divided into three regions and 11 governorates. The north area comprises: Jenin, Tulkarm, Nablus, Qalqilya and Tubas; the middle area comprises: Jerusalem, Ramallah, Salfit, and Jericho; the south area comprises: Bethlehem and Hebron [36].

This study was carried out in the north district of the West Bank of Palestine, where a list of hospitals and their addresses was acquired from the Ministry of Health. Based on the lists, the study held the following governmental hospitals in the north of the West Bank: Nablus, Jenin, Tulkarm, Qalqilya, and Tubas.

Study population
The population was chosen from nurses who worked in governmental hospitals in the north of the West Bank. 4362 registered nurses work in governmental health care units in Palestine. There are seven universities in the West Bank from which nurses with different specialties graduate [36].

Sampling procedure and sample size calculation
This study used convenience samples from nurses from governmental hospitals in the north district of the West Bank of Palestine, from May 2019 to February 2020. We interviewed all study participants in the wards of the above mentioned hospitals. First, all aspects of the study were explained in detail. Second, informed verbal consent was obtained. Third, we collected all data, including sociodemographic data from the participants themselves through a face-to-face interview. Each interview took about 15 min.

The data from the Palestinian Health Information Centre in 2014 found that 1566 nurses worked in the governmental hospitals in the West Bank of Palestine [37]. Generally, we assumed that about 400 nurses who worked in hospitals would be incorporated in the current study. We calculate the sample size for our study using the Raosoft sample size calculator (http://www.raosoft.com/samplesize.html). The sample size was 200 nurses, to achieve a confidence level of 95% and a margin of error of 5%.

Inclusion and exclusion criteria
The inclusion criteria were nurses of Palestinian nationality and licensed by the Palestinian Ministry of Health; having at least diploma or higher degree; and were working in ER, ICU, MW or paediatric departments. Exclusion criteria were nurses who refused to participate in the study, students from nursing school, and those who worked in private or teaching hospitals.

Instruments and data collection form
The questionnaire used consisted of five parts that had been developed by the previous studies [32, 38–42]. The prepared questionnaire consisted of open and closed questions. The questionnaire contained five parts:

- The first part was about demographic data, which contained questions about age, gender, the region of residence, marital status, educational level, position, years of work experience, CPR experience, and training that can affect knowledge of resuscitation medications.
- In the second section, we evaluated nurses’ knowledge of resuscitation medications, which consisted of 20 questions. The degree of knowledge about resuscitation medications was determined according to the nurse’s score. From the choices of true/false/I don’t know, we calculated the correct answer rate on knowledge of pharmacology and analyzed the effects of demographic data on knowledge score.
- The third section was designed for nurse self-evaluation for the following three factors regarding resuscitation medications:
  - Obstacles they faced and reasons for why medication administration errors occurred, indicating their level of agreement using a five-point Likert-type scale with fixed values ranging from 5 = ‘strongly agree’ to 1 = ‘strongly disagree’ for 20 items.
  - The degree of their level (five levels to choose from ‘sufficient’ to ‘extremely insufficient’).
  - Their need for training (three choices: ‘need’, ‘no comment’, and ‘no need’).
- The fourth section included 15 items to find the causes behind not reporting ME. Nurses were asked to indicate their level of agreement using a five-point Likert-type scale with fixed values ranging from 5 = ‘strongly agree’ to 1 = ‘strongly disagree’.
- The fifth part consisted of five items regarding suggestions to decrease ME. Nurses were asked to choose their level of agreement using a five-
point Likert scale with fixed values ranging from $5 = \text{‘strongly agree’}$ to $1 = \text{‘strongly disagree’}$.

**Ethical approval**

All aspects of the study protocol, including access to and use of the information of the participants, were approved by the Institutional Review Boards of An-Najah National University (IRB) (Ethical approval code: #7 May 2018). Furthermore, we obtained approval from the local health authorities of the four hospitals studied. Verbal consent was obtained from all participants.

**Pilot study**

The validity of the questionnaire’s content was checked by consensus of a group of three experts in the field drawn from academia (two experts in clinical pharmacy and one expert in clinical pharmacology). All experts confirmed that the questionnaire issues strictly adhered to the goals of the research. A pilot study (25 participants) was conducted to ensure the simplicity of the availability of the study questions, ensure the required data, estimate the time required, and modify the data collection form as appropriate. Nurses who participated in the pilot study were excluded from the final analysis.

**Statistical analysis**

Data were entered and analyzed using the Statistical Package for Social Sciences programme version 15 (SPSS). We expressed the data as continuous means ± standard deviation (SD) variables and as frequencies (percentages) for categorical variables. Non-normally distributed variables were expressed as medians (lower–upper quartiles). The normality of the variables was tested using the Kolmogorov–Smirnov test. The chi-square or the Fisher exact test was used to test significance between categorical variables, as appropriate. We used the Kruskal–Wallis test or Mann–Whitney U test to test for differences in the mean between categories. The significance level was established at $p < 0.05$.

**Results**

**Sociodemographic data**

This study was hospital-based in health care with a cross-section method, which was carried out with 200 nurses who worked in government hospitals in the north of West Bank of Palestine. As Table 1 indicates, half of the participants (approximately 51.5%) were women. Most of them (82%) were younger than 40 years of age and most of the participants were married (81.5%). Other demographic characteristics of nurses are represented in Table 1.

| Table 1. Socio-demographic characteristics of the study sample |
|---------------------------------------------------------------|
| **Variable** | **Frequency (%)** |
| **Gender** | |
| Male | 97 (48.5) |
| Female | 103 (51.5) |
| **Age category (Years)** | |
| 20–29 | 72 (36.0) |
| 30–39 | 93 (46.5) |
| 40–49 | 28 (14.0) |
| 50–59 | 7 (3.5) |
| **Marital status** | |
| Single, divorced, widow | 37 (18.5) |
| Married | 163 (81.5) |
| **Hospital** | |
| Rafedia | 35 (17.5) |
| Al-watany | 33 (16.5) |
| Jenin | 27 (13.5) |
| Tubas | 21 (10.5) |
| Tulkarm | 45 (22.5) |
| Qalqelia | 39 (19.5) |
| **Department** | |
| ER | 35 (17.5) |
| ICU | 27 (13.5) |
| NICU | 21 (10.5) |
| Paediatric | 33 (16.5) |
| Men ward | 41 (20.5) |
| Women Ward | 28 (14.0) |
| CCU | 7 (3.5) |
| Gynaecological ward | 4 (2.0) |
| General | 4 (2.0) |
| **Position** | |
| Staff nurse | 185 (92.5) |
| Head nurse | 11 (5.5) |
| Supervisor | 4 (2.0) |
| **Residency** | |
| Tulkarm | 47 (23.5) |
| Nablus | 67 (33.5) |
| Jenin | 37 (18.5) |
| Qalqelia | 40 (20.0) |
| Tubas | 9 (4.5) |
| **Years of working** | |
| Less than 5 years | 49 (24.5) |
| 5 to less than 10 | 71 (35.5) |
| 10 years or more | 80 (40.0) |
| **Educational status** | |
| Diploma | 51 (25.5) |
| BS | 129 (64.5) |
| MS | 20 (10.0) |
| **CPR Training** | |
| Yes | 175 (87.5) |
| No | 25 (12.5) |

*ER emergency room, ICU intensive care unit, NICU neonatal intensive care unit, MW medical ward, CCU cardiac/coronary care unit, BS bachelor degree, MS master degree*
Knowledge about the administration of resuscitation medications

We asked nurses about the proper administration of resuscitation medications, and the correct response rate was 58.6%; 28.2% were incorrect answers, and 13.2% answered ‘don’t know’. We found that question number 11, about the use of atropine in the treatment of pulseless electrical activity, received the lowest correct response rate: only 36.5% answered correctly. On the contrary, the highest correct response rate was 87.5%, agreeing that KCl is not administered as a fast IV push in an emergency event such as ventricular fibrillation. More than half of the nurses did not understand that when they calculated the dose of epinephrine (adrenaline) for children, they must use body weight and not body surface area (correct rate 44.5%). Furthermore, most nurses thought that drugs should be available in multiple concentrations to choose, although this is unacceptable (correct rate 41.5%) (Table 2).

| Questions                                                                 | Answer | Correct answer n (%) | Incorrect answer n (%) | Don’t know the answer n (%) |
|---------------------------------------------------------------------------|--------|-----------------------|------------------------|-----------------------------|
| 1. 10 mls fast IV push of 15% KCl is given in an emergency cases for example ventricular fibrillation case | F      | 175 (87.5)            | 13 (6.5)               | 12 (6.0)                    |
| 2. In the cardiac arrest case we give rapid IV push 1 mg epinephrine within 3–5 min | T      | 138 (69.0)            | 46 (23.0)              | 16 (8.0)                    |
| 3. We favoured small venous vessels in case of dopamine injection         | F      | 139 (69.5)            | 37 (18.5)              | 24 (12.0)                   |
| 4. To preserve norepinephrine bitartrate effect we add glucose water to it| T      | 107 (53.5)            | 64 (32.0)              | 29 (14.5)                   |
| 5. We inject NaHCO3 with epinephrine to cause an additive effect of the drug | F      | 115 (57.5)            | 32 (16)                | 53 (26.5)                   |
| 6. To avoid hypoglycaemia occurrence, glucose water should constantly be given when starting CPR procedure | F      | 112 (56.0)            | 64 (32.0)              | 24 (12.0)                   |
| 7. We can interchange between 10% Ca glucose and 10% CaCl2 because they are the same drug | F      | 136 (68.0)            | 20 (10.0)              | 44 (22.0)                   |
| 8. Amiodarone is used to treat bradycardia                               | F      | 138 (69.0)            | 43 (21.0)              | 19 (9.5)                    |
| 9. Nitroglycerine is used to treat cardiac infarction, which is accompanied by a drop in blood pressure and bradycardia | F      | 133 (66.5)            | 50 (25.0)              | 17 (8.5)                    |
| 10. 1 amp of 1:1000 epinephrine is given as fast IV push in case of a mild allergic reaction | F      | 110 (55.0)            | 64 (32.0)              | 26 (13.0)                   |
| 11. In the case of pulseless electrical activity, atropine is used within the treatment | F      | 73 (36.5)             | 112 (56.0)             | 15 (7.5)                    |
| 12. Atracurium should be stored with other drugs and easily accessed by nurses | F      | 114 (57.0)            | 64 (32.0)              | 22 (11.0)                   |
| 13. If we give the drugs endotracheally, the dosage should be increased 5 to 10 times than IV dose | F      | 103 (51.5)            | 48 (24.0)              | 49 (24.5)                   |
| 14. To avoid bradycardia, give a small dose of atropine (< 0.5 mg) in case of CPR | F      | 101 (50.0)            | 77 (38.5)              | 22 (11.0)                   |
| 15. Adenosine is given for bradycardia as slow IV drip (> 10 min)        | F      | 130 (65.0)            | 54 (27.0)              | 16 (8.0)                    |
| 16. The first choice of treatment in case of ventricular tachycardia or fibrillation is lidocaine | F      | 119 (59.5)            | 56 (28.0)              | 25 (12.5)                   |
| 17. Rapid IV push 10% CaCl2, 10 ml over 1–2 min is given in the emergency cases | F      | 93 (46.5)             | 70 (35.0)              | 37 (18.5)                   |
| 18. Various concentrations of all drugs should be available to choose by nurses | F      | 83 (41.5)             | 102 (51.0)             | 15 (7.5)                    |
| 19. Epinephrine dose calculation is based on body surface area in paediatric CPR | F      | 89 (44.5)             | 89 (44.5)              | 22 (11.0)                   |
| 20. Amiodarone is best given endotracheally, to increase its effect       | F      | 137 (68.5)            | 25 (12.5)              | 38 (19.0)                   |

Mean 58.6

Table 2 Resuscitation medications administration knowledge

knowledge score and sociodemographic variables

The knowledge scale consisted of 20 questions to measure the knowledge among nurses about resuscitation medications. As shown in Table 3, the median knowledge score for male participants was high (13; quartile range 10–16) compared to females. The median knowledge for age category, 20 to 29 years was 12.5 (9–16), 30 to 39 years was 12 (8–15), 40–49 years was 11 (8.25–14.75), and 50 to 59 years was 13 (9–15), respectively. The participants who married had a median knowledge score of 12 (9–15), while the single, divorced and widowed nurses had a score of 13 (8.5–15). A high median knowledge score was observed in nurses who worked in the CCU department (16; 15–17), and that worked in the general wards 17.5 (14.75–18.75) and whose position was a supervisor 17.5 (14.75–18.75). Furthermore, the years of working showed the same median knowledge scale (12; 8–15.5); nurses having a master’s degree showed a higher knowledge score, 14 (9.25–15.75), and also those who

IV intravenous, KCl potassium chloride, NaHCO3 sodium bicarbonate, CPR Cardiopulmonary resuscitation, Ca calcium, CaCl2 calcium chloride, Amp ampoule
| Variable                  | Frequency (%) | Median k (Q1–Q3) | Mean rank | P-value |
|---------------------------|---------------|------------------|-----------|---------|
| Gender                    |               |                  |           |         |
| Male                      | 97 (48.5)     | 13 (10–16)       | 114.59    | 0.001a  |
| Female                    | 103 (51.5)    | 10 (8–14)        | 87.23     |         |
| Age category (Years)      |               |                  |           |         |
| 20–29                     | 72 (36.0)     | 12.5 (9–16)      | 106.58    |         |
| 30–39                     | 93 (46.5)     | 12 (8–15)        | 98.77     |         |
| 40–49                     | 28 (14.0)     | 11 (8.25–14.75)  | 91.45     | 0.661b  |
| 50–59                     | 7 (3.5)       | 13 (9–15)        | 97.14     |         |
| Marital status            |               |                  |           |         |
| (single, divorced, widow) | 37 (18.5)     | 13 (8.5–15)      | 100.82    |         |
| Married                   | 163 (81.5)    | 12 (9–15)        | 100.43    | 0.970a  |
| Hospital                  |               |                  |           |         |
| Rafedia                   | 35 (17.5)     | 12 (8–14)        | 94.13     |         |
| Al-watany                 | 33 (16.5)     | 13 (10–16)       | 112.24    |         |
| Jenin                     | 27 (13.5)     | 11 (8–15)        | 96.39     | 0.194d  |
| Tubas                     | 21 (10.5)     | 11 (8–14)        | 92.95     |         |
| Tulkarm                   | 45 (22.5)     | 14 (10–16)       | 114.59    |         |
| Qalqelia                  | 39 (19.5)     | 10 (7–15)        | 86.51     |         |
| Department                |               |                  |           |         |
| ER                        | 35 (17.5)     | 13 (10–15)       | 109.46    |         |
| ICU                       | 27 (13.5)     | 14 (11–15)       | 119.72    |         |
| NICU                      | 21 (10.5)     | 12 (8–16)        | 99.02     |         |
| Paediatric                | 33 (16.5)     | 9 (7.5–13)       | 73.2      | 0.006f  |
| Men Ward                  | 41 (20.5)     | 11 (9–16)        | 101.78    |         |
| Women Ward                | 28 (14.0)     | 10 (8–13)        | 78.16     |         |
| CCU                       | 7 (3.5)       | 16 (15–17)       | 155.79    |         |
| Gynaecological Ward       | 4 (2.0)       | 10.5 (2.25–18)   | 98        |         |
| General                   | 4 (2.0)       | 17.5 (14.75–18.75) | 174.38 |         |
| Position                  |               |                  |           |         |
| Staff nurse               | 185 (92.5)    | 12 (8.5–15)      | 99.08     |         |
| Head nurse                | 11 (5.5)      | 14 (9–15)        | 97.45     | 0.035b  |
| Supervisor                | 4 (2.0)       | 17.5 (14.75–18.75) | 174.38 |         |
| Residency                 |               |                  |           |         |
| Tulkarm                   | 47 (23.5)     | 13 (10–16)       | 111.85    |         |
| Nablus                    | 67 (33.5)     | 12 (9–15)        | 101.31    | 0.538b  |
| Jenin                     | 37 (18.5)     | 10 (8.5–14.5)    | 92.81     |         |
| Qalqelia                  | 40 (20.0)     | 11.5 (7.25–15.75) | 95.34 |         |
| Tubas                     | 9 (4.5)       | 12 (8–14)        | 89.72     |         |
| Years of working          |               |                  |           |         |
| Less than 5 years         | 49 (24.5)     | 12 (8–15.5)      | 100.11    |         |
| 5 to less than10          | 71 (35.5)     | 12 (9–16)        | 104.74    | 0.710f  |
| 10 years or more          | 80 (40.0)     | 12.5 (8–15)      | 96.98     |         |
| Educational status        |               |                  |           |         |
| Diploma                   | 51 (25.5)     | 11 (7–15)        | 93.18     |         |
| BS                        | 129 (64.5)    | 12 (9–15)        | 100.48    | 0.230f  |
| MS                        | 20 (10.0)     | 14 (9.25–15.75)  | 119.28    |         |
| CPR Training              |               |                  |           |         |
| Yes                       | 175 (87.5)    | 13 (9–15)        | 102.83    | 0.131a  |
| No                        | 25 (12.5)     | 9 (7–16.5)       | 84.18     |         |

ER emergency room, ICU intensive care unit, NICU neonatal intensive care unit, MW medical word, CCU cardiac/coronary care unit, BS bachelor degree, MS master degree

* Statistical significance of differences calculated using the Mann–Whitney U-test

b Statistical significance of differences calculated using the Kruskal–Wallis test
had CPR training showed a higher knowledge score, 13 (9–15).

Table 3 shows the knowledge score by sociodemographic variables score. A high knowledge score was associated with men (p = 0.001), and also shows a significant difference according to the department they worked, with a high knowledge score associated with the CCU, ICU, and general (p < 0.001); moreover, there was a significant difference between nurses according to the position and knowledge score. A high knowledge score was associated with being a supervisor (p = 0.035). No significant differences were observed between nurses according to age, marital status, hospital, residency, years of work, educational status, and CPR training.

**Description of the obstacles that nurses encountered**

Table 4 describes the obstacles that nurses encountered when giving the medications to patients that caused ME to occur. The results show that about half of the nurses (46.5%) agreed that an obstacle was the names of many medications were similar, but 40% disagreed. More than half of the nurses (60%) agreed that the packaging was also an obstacle, while only (38%) agreed that mixing of resuscitation medications with other drugs was an obstacle. About half of the nurses agreed that the abbreviations used instead of writing the orders out completely and oral orders instead of written orders were not helpful. Confusing prescriptions and unclear dose calculations were also obstacles, but 42% disagreed that the pharmacy delivered incorrect doses and 31.5% agreed with this; 46.5% disagreed that the pharmacy did not label the medication correctly compared to 38% disagreed, and more than half (61%) agreed that pharmacists not staying all day was an obstacle (23% disagreed). 39% agreed that poor communication between physicians and nurses was an obstacle and 43% did not; only 26.5% disagreed that there was insufficient knowledge on resuscitation medications.

Table 4 also shows that more than half (53.5%) of nurses took unconfirmed information from colleagues, moreover, 54.5% of them agreed that there was a disagreement of opinions between doctors and nurses. 49.5% of nurses said that there were no references to refer to for resuscitation medications, and only 31% disagreed. 45% of nurses were embarrassed to ask questions about resuscitation medications and 36.5% did not. It was acknowledged that interruptions during drug administration procedures among nurses (e.g., being asked to handle other tasks) were an obstacle for about half of them (48.5%), but not for 33.5%. Only 21% did not consider that the general chaotic conditions in the CPR procedure (such as many people handling a single drug) was an obstacle, and more than half of nurses considered that deficiency and inaccessibility to resuscitation medications and the ignorance of patient allergies were obstacles.

**Classify nurses according to knowledge level and training need**

Table 5 describes that 60% of nurses see that they have ‘sufficient’ or “relatively sufficient” knowledge levels about resuscitation medications and only 19% see that they have “insufficient knowledge”; most of them (70.5%) said that they needed further training about resuscitation medications.

**Causes of medication administration errors not reported**

Table 6 shows why medication administration errors are not reported. More than half of nurses (58%) agreed that the differences between the nurses’ and hospital definition of a “ME” was a reason not to report an error, however, 48% of them did not consider that not recognising errors occurred as a reason for this (15% neutral). 41.5% of nurses did not consider that filling out an incident report for an EM takes a long time (21% neutral), while 42.5% considered that contacting the physician about an error takes a long time and was a reason not to report an error (18.5% neutral). More than half of the nurses (53.5%) agreed that ME are defined vaguely, while half of them (49.5%) disagreed that nurses think that the mistake was not important to report (16.5% neutral). 55% of nurses thought that other nurses would think they are unqualified if they make ME and so did not report it, and 67.5% were afraid that patients or their families might develop a negative attitude toward them, or take legal action against them, and so they did not report ME (12% neutral). 46% were worried that the physician would reprimand them for ME (17.5% neutral), and more than half (61.5%) of the nurses panicked about adverse consequences of reporting ME (12.5% neutral); 54% of them agreed that the nursing administration did not take the proper action that matched the severity of the errors (23.5% neutral) and most of the nurses (71.5%) said that they could be blamed if something happened to the patient as a consequence of ME and so did not report it. 59% said that they did not see encouragement for correctly administering medication (20.5% neutral), but a high value was attributed to an EM as an indication of medical care provided by nurses, therefore, 62.5% of nurses did not report errors; most nurses (71.5%) noticed that nursing administrators focused on the person rather than the system when a ME occurred.
| Variable                                      | Frequency (%) |
|----------------------------------------------|---------------|
| **The similarity of medications name**       |               |
| Strongly agree                               | 29 (14.5)     |
| Agree                                        | 64 (32.0)     |
| Neither agree or disagree                    | 27 (13.5)     |
| Disagree                                     | 65 (32.5)     |
| Strongly disagree                            | 15 (7.5)      |
| **Different medications look-alike in the packaging** |     |
| Strongly agree                               | 33 (16.5)     |
| Agree                                        | 89 (44.5)     |
| Neither agree or disagree                    | 20 (10.0)     |
| Disagree                                     | 38 (19.0)     |
| Strongly disagree                            | 20 (10.0)     |
| **Mixing of resuscitation medications with other drugs** |         |
| Strongly agree                               | 34 (17.0)     |
| Agree                                        | 42 (21.0)     |
| Neither agree or disagree                    | 25 (12.5)     |
| Disagree                                     | 68 (34.0)     |
| Strongly disagree                            | 31 (15.5)     |
| **Use Abbreviations in place of writing the whole orders** | |
| Strongly agree                               | 36 (18.0)     |
| Agree                                        | 67 (33.5)     |
| Neither agree or disagree                    | 33 (16.5)     |
| Disagree                                     | 52 (26.0)     |
| Strongly disagree                            | 12 (6.0)      |
| **Verbal orders are used instead of written orders** | |
| Strongly agree                               | 41 (20.5)     |
| Agree                                        | 65 (32.5)     |
| Neither agree or disagree                    | 34 (17.0)     |
| Disagree                                     | 40 (20.0)     |
| Strongly disagree                            | 20 (10.0)     |
| **Confused prescription**                    |               |
| agree Strongly                               | 40 (20.0)     |
| Agree                                        | 61 (30.5)     |
| Neither agree or disagree                    | 44 (22.0)     |
| Disagree                                     | 41 (20.5)     |
| Strongly disagree                            | 14 (7.0)      |
| **Unclear dose calculation**                 |               |
| agree Strongly                               | 32 (16.0)     |
| Agree                                        | 64 (32.0)     |
| Neither agree or disagree                    | 37 (18.5)     |
| Disagree                                     | 52 (26.0)     |
| Strongly disagree                            | 15 (7.5)      |
| **Pharmacy delivers incorrect doses**        |               |
| Strongly agree                               | 26 (13.0)     |
| Agree                                        | 37 (18.5)     |
| Neither agree or disagree                    | 51 (25.5)     |
| Disagree                                     | 63 (31.5)     |
| Strongly disagree                            | 23 (11.5)     |
| Variable                                                                 | Frequency (%) |
|--------------------------------------------------------------------------|---------------|
| The pharmacy does not label the medication correctly                     |               |
| Strongly agree                                                           | 27 (13.5)     |
| Agree                                                                    | 49 (24.5)     |
| Neither agree or disagree                                                | 31 (15.5)     |
| Disagree                                                                 | 74 (37.0)     |
| Strongly disagree                                                        | 19 (9.5)      |
| Unavailability of pharmacists throughout the day                          |               |
| Strongly agree                                                           | 52 (26.0)     |
| Agree                                                                    | 70 (35.0)     |
| Neither agree or disagree                                                | 32 (16.0)     |
| Disagree                                                                 | 34 (17.0)     |
| Strongly disagree                                                        | 12 (6.0)      |
| Lack of communication between doctors and nurses                         |               |
| Strongly agree                                                           | 27 (13.5)     |
| Agree                                                                    | 51 (25.5)     |
| Neither agree or disagree                                                | 36 (18.0)     |
| Disagree                                                                 | 70 (35.0)     |
| Strongly disagree                                                        | 16 (8.0)      |
| Insufficient knowledge regarding resuscitation medications               |               |
| Strongly agree                                                           | 41 (20.5)     |
| Agree                                                                    | 56 (28.0)     |
| Neither agree or disagree                                                | 50 (25.0)     |
| Disagree                                                                 | 40 (20.0)     |
| Strongly disagree                                                        | 13 (6.5)      |
| Perception of uncertain answers from other nurses                        |               |
| Strongly agree                                                           | 34 (17.0)     |
| Agree                                                                    | 73 (36.5)     |
| Neither agree or disagree                                                | 41 (20.5)     |
| Disagree                                                                 | 45 (22.5)     |
| Strongly disagree                                                        | 7 (3.5)       |
| Divergence of opinions between doctor and nurse                          |               |
| Strongly agree                                                           | 41 (20.5)     |
| Agree                                                                    | 68 (34.0)     |
| Neither agree or disagree                                                | 35 (17.5)     |
| Disagree                                                                 | 48 (24.0)     |
| Strongly disagree                                                        | 8 (4.0)       |
| No references for the use of resuscitation medications                  |               |
| Strongly agree                                                           | 48 (24.0)     |
| Agree                                                                    | 51 (25.5)     |
| Neither agree or disagree                                                | 39 (19.5)     |
| Disagree                                                                 | 52 (26.0)     |
| Strongly disagree                                                        | 10 (5.0)      |
| Embarrassment from asking colleagues about resuscitation drugs           |               |
| Strongly agree                                                           | 30 (15.0)     |
| Agree                                                                    | 60 (30.0)     |
| Neither agree or disagree                                                | 37 (18.5)     |
| Disagree                                                                 | 57 (28.5)     |
| Strongly disagree                                                        | 16 (8.0)      |
Suggestions for decreasing ME

Table 7 shows that most nurses strongly agreed on the solutions I suggested to them: 1) better arrangement of medications by names, labels, and packages can increase correct and safe use of healthcare providers (71.5%); 2) create a continuous learning and training program for nursing staff (71%); 3) prepare a trained CPR team is necessary for professional resuscitation action (65%) called “code blue”; 4) provide better access to reference information about drugs (69%), and 5) provide a clinical pharmacist in the departments as a reference for medicines to help nurses (66.5%).

In addition, some of the nurses suggested other solutions, such as increasing the number of nurses on staff to decrease the general workload, establishing an electronic medical library within reach of nursing hands, and giving value to the nursing role when dealing with them and not treating them just as a tool to execute orders.

Discussion

This study is one of the first in Palestine that has been performed to determine factors that affect nurses’ knowledge about resuscitation medication, discuss the obstacles they encountered during medication administration, explain the causes behind not reporting ME and suggest solutions to decrease ME.

Insufficient knowledge among nurses is considered one of the most important reasons for medication administration errors [3, 4, 42].

In our study, the correct answer rate regarding high-alert medications was only 58.6%, which was quite low compared to a similar study done in Taiwan 70.5% [32],

Table 4 (continued)

| Variable | Frequency (%) |
|----------|---------------|
| Interruption during drug administration to do other tasks at the same time |  |
| Strongly agree | 40 (20.0) |
| Agree | 57 (28.5) |
| Neither agree or disagree | 36 (18.0) |
| Disagree | 54 (27.0) |
| Strongly disagree | 13 (6.5) |
| General mess during resuscitation as many people are handling the same medication |  |
| Strongly agree | 61 (30.5) |
| Agree | 63 (31.5) |
| Neither agree or disagree | 34 (17.0) |
| Disagree | 36 (18.0) |
| Strongly disagree | 6 (3.0) |
| Shortage of resuscitation medications and need to borrow from other wards |  |
| Strongly agree | 47 (23.5) |
| Agree | 60 (30.0) |
| Neither agree or disagree | 32 (16.0) |
| Disagree | 48 (24.0) |
| Strongly disagree | 13 (6.5) |
| The nurse is unaware of a known allergy |  |
| Strongly agree | 49 (24.5) |
| Agree | 69 (34.5) |
| Neither agree or disagree | 31 (15.5) |
| Disagree | 42 (21.0) |
| Strongly disagree | 9 (4.5) |

Table 5

| Variable | Frequency (%) |
|----------|---------------|
| In your opinion, your knowledge level about resuscitation medications is; |  |
| Sufficient | 38 (19.0) |
| Relatively sufficient | 82 (41.0) |
| Fair | 42 (21.0) |
| Insufficient | 32 (16.0) |
| Extremely insufficient | 6 (3.0) |
| In your opinion, do you need training about resuscitation medications; |  |
| Need | 141 (70.5) |
| No comment | 32 (16.0) |
| No need | 27 (13.5) |
### Table 6  Causes of medication administration errors not reporting

| Variable                                                                 | Frequency (%) |
|-------------------------------------------------------------------------|---------------|
| **There is no compatibility in the definition of a medication error between hospitals and nurses** |               |
| Strongly agree                                                          | 29 (14.5)     |
| Agree                                                                   | 87 (43.5)     |
| Neither agree or disagree                                                | 37 (18.5)     |
| Disagree                                                                | 42 (21.0)     |
| Strongly disagree                                                        | 5 (2.5)       |
| **Nurses aren’t aware of the error happening**                           |               |
| Strongly agree                                                          | 23 (11.5)     |
| Agree                                                                   | 51 (25.5)     |
| Neither agree or disagree                                                | 30 (15.0)     |
| Disagree                                                                | 66 (33.0)     |
| Strongly disagree                                                        | 30 (15.0)     |
| **Filling out the incident report form takes a lot of time**             |               |
| Strongly agree                                                          | 29 (14.5)     |
| Agree                                                                   | 46 (23.0)     |
| Neither agree or disagree                                                | 42 (21.0)     |
| Disagree                                                                | 70 (35.0)     |
| Strongly disagree                                                        | 13 (6.5)      |
| **It takes a lot of time to contact a doctor about a medication error** |               |
| Strongly agree                                                          | 26 (13.0)     |
| Agree                                                                   | 59 (29.5)     |
| Neither agree or disagree                                                | 37 (18.5)     |
| Disagree                                                                | 67 (33.5)     |
| Strongly disagree                                                        | 11 (5.5)      |
| **The definition of a medical error is not obvious**                     |               |
| Strongly agree                                                          | 30 (15.0)     |
| Agree                                                                   | 77 (38.5)     |
| Neither agree or disagree                                                | 35 (17.5)     |
| Disagree                                                                | 49 (24.5)     |
| Strongly disagree                                                        | 9 (4.5)       |
| **Nurses believe a medical error is insignificant enough to document**  |               |
| Strongly agree                                                          | 24 (12.0)     |
| Agree                                                                   | 44 (22.0)     |
| Neither agree or disagree                                                | 33 (16.5)     |
| Disagree                                                                | 73 (36.5)     |
| Strongly disagree                                                        | 26 (13.0)     |
| **Nurses believe that their colleagues will think they are incompetent when making a medical error** |               |
| Strongly agree                                                          | 40 (20.0)     |
| Agree                                                                   | 70 (35.0)     |
| Neither agree or disagree                                                | 29 (14.5)     |
| Disagree                                                                | 44 (22.0)     |
| Strongly disagree                                                        | 17 (8.5)      |
| **Patients or their families might have developed a negative attitude toward the nurses, or take legal action if they report a medication error** |               |
| Strongly agree                                                          | 50 (25.0)     |
| Agree                                                                   | 85 (42.5)     |
| Neither agree or disagree                                                | 24 (12.0)     |
| Disagree                                                                | 33 (16.5)     |
| Strongly disagree                                                        | 8 (4.0)       |
and 60.9%, 56.5%, 75.8% in studies done in Palestine and Taiwan, respectively [38, 39, 42], also proves that nurses are lacking information about resuscitation medications and high-alert medications. The question about giving 15% KCl as an IV push in emergency cases such as ventricular fibrillation achieved the correct answer rate of 87.5%, which showed good knowledge of how to avoid ME which can cause cardiac arrest and death; It was a higher rate compared to a study done in Palestine on high alert medications which was 76.8% [42], but lower than a similar study conducted in Taiwan (95.2%) [32], and the same result as Lu et al. [38]. 68.5% of nurses
gave a correct answer to not giving amiodarone by the trachea to increase the effects, which is considered high compared to the same study done in Taiwan, which only achieved 42.0% [32], but still low, because there is no absorption for amiodarone through the trachea [43]. On the contrary, 63.5% of nurses still thought that atropine could be used in pulseless electrical activity treatment, which was the lowest correct answer rate, while only 29.8% of nurses answered incorrectly / do not know about this question [32] which indicates low knowledge. The next lowest correct answer rate was 44.5%, representing that more than half of the nurses who did not know that body weight is used in an epinephrine dose calculation for resuscitation of a child, which is a comparable result with a study conducted in Taiwan [32]. Calcium chloride (CaCl2) injection should be administered gradually in a large vein, but 53.5% of nurses did not recognize this error; the same result was found by Zyoud et al. [42], while only 39.2%, 49% of nurses incorrectly answered in studies done in Taiwan [32, 38]. 32% of nurses incorrectly answered about the inability to switch between 10% Ca gluconate and 10% CaCl2, which is the same result in a study conducted in Palestine [42], but a lower correct rate than studies in Taiwan [32, 38].

To increase nurses’ pharmacological knowledge of resuscitation medication and increase patient safety, the common obstacles that nurses face and the ones that lead them to make errors should be known. In our study, we found that the major obstacle nurses faced when administering resuscitation medication was a chaotic environment during CPR, for example, with many people handling a single drug (62%). This was the third of 12 obstacles that nurses faced in a study completed by Chen et al. [32], and Ornato et al. also mentioned that

### Table 7  Suggestion for decrease medication errors

| Variable                                                                 | Frequency (%) |
|-------------------------------------------------------------------------|---------------|
| **Good arrangement of medications by names, labels, and packages can increase correct and safe use by healthcare providers** |               |
| Strongly agree                                                          | 143 (71.5)    |
| Agree                                                                   | 46 (23.0)     |
| Neither agree or disagree                                               | 6 (3.0)       |
| Disagree                                                                | 2 (1.0)       |
| Strongly disagree                                                       | 3 (1.5)       |
| **Make continuous learning and training to nurses’ staff**              |               |
| Strongly agree                                                          | 142 (71.0)    |
| Agree                                                                   | 44 (22.0)     |
| Neither agree or disagree                                               | 8 (4.0)       |
| Disagree                                                                | 5 (2.5)       |
| Strongly disagree                                                       | 1 (0.5)       |
| **Preparing a trained CPR team is necessary for professional resuscitation action** |               |
| strongly agree                                                          | 130 (65.0)    |
| Agree                                                                   | 55 (27.5)     |
| Neither agree or disagree                                               | 11 (5.5)      |
| Disagree                                                                | 3 (1.5)       |
| Strongly disagree                                                       | 1 (0.5)       |
| **Provide a more effective source or reference for information about the drug** |               |
| Strongly agree                                                          | 138 (69.0)    |
| Agree                                                                   | 47 (23.5)     |
| Neither agree or disagree                                               | 9 (4.5)       |
| Disagree                                                                | 5 (2.5)       |
| Strongly disagree                                                       | 1 (0.5)       |
| **Providing clinical pharmacists in the departments as a reference for medicines to help nurses** |               |
| Strongly agree                                                          | 133 (66.5)    |
| Agree                                                                   | 44 (22.0)     |
| Neither agree or disagree                                               | 14 (7.0)      |
| Disagree                                                                | 7 (3.5)       |
| Strongly disagree                                                       | 2 (1.0)       |

CPR Cardiopulmonary resuscitation
too many individuals present in the resuscitation room, as well as poor teamwork and leadership, could result in errors in the resuscitation system [44]. Furthermore, the inaccessibility of pharmacists for the whole day (61%) and the similarity of different medications packaging (61%) were further obstacles.

Several studies found that a deficiency in pharmacological knowledge is the major reason for ME. For example, inadequate knowledge was the main obstacle that nurses faced in Taiwan (75.4%) [39], and 28.2% of nurses considered it an obstacle [32]. Furthermore, in our research, 48.5% of nurses considered having inadequate knowledge as a major obstacle, while another study considered interruptions during drug administration as the main obstacle 62.8% [32], while 48.5% of nurses in our study agreed with that, another studied poor communication between nurses and physicians was an important obstacle [11, 42]. In our study, 39% of nurses considered it essential to establish more trained and cooperative CPR teams for professional resuscitation action.

38% of nurses believed they had sufficient knowledge levels about resuscitation medications, while only 8% of nurses in Taiwan thought that [32], and only 3.6% and 23.6% of nurses believed themselves to have adequate knowledge on high-alert medications in Taiwan and Palestine, respectively [39, 42]. Most nurses acknowledged that they needed training on resuscitation medications as well as other studies [32, 39, 42].

In our study, we found that there was no compatibility in the definition of ME between nurses and hospitals (43.5%), which was the main reason for not reporting medication administration. The other most important causes were the negative attitudes that patients and their families towards the nurse or that they may litigate against the nurse if an EM is reported (42.5%). If something happens to the patient, nurses thought that they would be blamed as a consequence of ME (42%), and that nursing management focused on the person (rather than the system) when ME occurs (42%) [45, 46]. The study by Mansouri et al. mentioned that the ME were not documented for three reasons: fear of consequences after reporting an error, procedural obstacles and management problems [47], and in our study, fear of adverse consequences was an important barrier to reporting incidents.

To improve ME reporting, we have to create an encouraging and supportive environment with no blame and dishonor when genuine mistakes are made. Teaching nurses how and what to report incidents and giving rewards to encourage incident reporting would help. Increasing the provision of corrective actions regarding incident reports, such as training health providers to recognise medical incidents, and the existence of a reporting system, would be beneficial [45].

We suggested solutions to increase patient safety, and the nurses agreed with them. These were; an improved arrangement of drug names, labels, and packages can increase proper use of medications by healthcare providers and improve patient safety; create a continuous learning and training program for nurses and staff [6, 42, 48]; prepare more trained and cooperative CPR teams to increase the efficiency of resuscitation actions [44]; provide a more effective source of reference for information about drugs, such as clinical pharmacy service, as it positively impacts the quality of care [49].

The nurses were found to lack sufficient information about the drugs they are giving. A positive direct effect was shown between the knowledge score and the male participants ($p=0.001$). These findings are comparable with a study conducted by Zyoud et al. on high-alert drugs [42] and nurses working in CCU, ICU, and general wards ($p<0.001$). In Taiwan, the same result was found that nurses who worked in the ER or ICU departments had more knowledge than those who worked in the EMS and obstetric-paediaic wards [32]. In addition, on the medical and surgical wards, medical errors occurred more frequently, according to Sheu et al. [50].

Our study observed that there was a significant difference according to the position of the nurses, with supervisor nurses having a higher score compared to staff and principal nurses ($p=0.035$); Zyoud et al. also considered the position as a factor affecting the knowledge score and found head nurses had the highest score [42].

There was no significant relationship between the knowledge score and age, marital status, hospital, residency, years of work, education level, and CPR training. However, a positive relationship between years of work and the knowledge score had been found in several studies [32, 38, 39], educational level and the knowledge score [42], and also between the CPR training and the knowledge score [32].

**Strengths and limitations**

This study was one of the first to evaluate the knowledge and understanding of the obstacles they face when giving resuscitation medications to patients and the low reporting of ME in Palestine. However, our study had some limitations. First, this is a cross-sectional study and it is therefore difficult to prove causal relationships between the scales and their associated factors. Second, because the information was collected through face-to-face interviews, the interviewer’s bias can influence the results. Third, samples were collected only from the north area of the West Bank, which could be considered a limiting factor. Finally, we included all working nurses at the time of the study period and did not consider the status of
emotional or physical health situations during the selection process.

Implications for research/practice
This study is the first in the field of nursing in Palestine to concern nurses’ knowledge and obstacles when administering resuscitation medications. Establish a database for future studies in different professions in the medical field, and the results of this study help health care providers and health policymakers create mechanisms to decrease ME and establish clear protocols to increase patient safety as possible and improve health care in Palestinian hospitals. Nurses indicated that many factors and obstacles are the reasons for resuscitation medication administration errors, such as chaotic environment and the unavailability of pharmacists for a whole day. These obstacles should be considered to improve practice. Therefore, an evaluation of nurses’ knowledge is necessary to measure the degree of lack of information about resuscitation medications and to recognize the obstacles they face during medication administration. This will enable future activities and strategies to significantly and decrease deaths.

Conclusions
In conclusion, in our study, the correct answer rate was only 58.6%, which indicates poor knowledge among nurses, which is an obstacle that causes ME. Furthermore, this study has shown that a higher knowledge score was found in male nurses and nurses working in the CCU, ICU, and general departments, but no differences were observed between nurses with regard to age, marital status, hospital, residency, years of work, educational status, and CPR training.

This study identifies the causes of drug administration-related errors by nurses during cardiac resuscitation and offers solutions. It can be helpful when others perform similar studies in their own health care systems and geographical localities. According to our results, a chaotic condition in CPR conditions were the most common obstacle that nurses faced in administering resuscitation medication at a rate of 62%. Furthermore, there is no common agreement; also would like to have extra training to improve and update their pharmacology information. According to the results and conclusions of this study, pharmacists must better organize medications so that names, labels, and packages are clearer to find and use. Continuous learning and training for nurses staff, better preparation and organized training for CPR teams to carry out resuscitation actions in a coordinated and professional way as a code blue team; providing a more effective source of reference material for information about drugs for nurses, and providing a clinical pharmacist in all departments as reference help nurses.

This study gives a great deal of insight into the clinical context, especially for nurses’ practice. Therefore, comprehensive actions that can reduce nurses’ make fewer errors should be made following the study findings. First, hospitals should increase the number of nursing staff to reduce their workload on them. Second, establishing an electronic medical library within reach of nursing hands could give nurses valuable tools to execute orders. Lastly, organising a calm and disciplined CPR environment can improve communication between nurses and physicians to reduce ME.

Abbreviations
Amp: Ampoule; BS: Bachelor’s Degree; Ca: Calcium; CaCl2: Calcium Chloride; CCU: Cardiac / Coronary Care Unit; CPR: Cardiopulmonary Resuscitation; ER: Emergency Room; ICU: Intensive Care Unit; IRB: Institutional Review Boards; IV: Intravenous; KCl: Potassium Chloride; ME: Medication Error; MS: Master’s Degree; MW: Medical Word; NaHCO3: Sodium Bicarbonate; NICU: Neonatal Intensive Care Unit; NTI: Narrow Therapeutic Index; SD: Standard Deviation; SPSS: Statistical Package for Social Sciences.

Acknowledgements
The authors thank An-Najah National University and the Ministry of Health for giving us the opportunity to conduct this study.

Authors’ contributions
RQ and MD collected and analyzed the data, reviewed the literature, and contributed to the drafting of the manuscript. SA provided input on data analyses and interpretation of the results, reviewed the literature, and contributed to the conception and design of the study. AAK participated in the manuscript writing, reviewed the literature, updated the reference list, and responded to all reviewers’ comments. SZ conceptualized and planned the study; organized, monitored, and cared for data integrity and reliability of analysis; objectively checked the interpretation of the findings; and assisted in the manuscript’s final writing. All authors read and approved the final manuscript.

Funding
No funding was received for this study.

Availability of data and materials
The data sets used and/or analyzed during the current study are available from the corresponding authors on reasonable request.

Declarations
Ethics approval and consent to participate
All aspects of the study protocol, including access to and use of the information of the participants, were approved by the Institutional Review Boards of An-Najah National University (IRB) and the local health authorities before the initiation of this study. The IRB of An-Najah National University approved only verbal consent. Because we did not collect any identification information during the interview and our study did not pose a major risk to participants, the IRB of An-Najah National University waived the requirement for written informed consent. The authors confirmed that all the methods were performed following the relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.
Author details

1 Department of Clinical and Community Pharmacy, College of Medicine and Health Sciences, An-Najah National University, Nablus 44839, Palestine.
2 Division of Clinical Pharmacy, Department of Hematology and Oncology, An-Najah National University Hospital, Nablus 44839, Palestine. 3 Poison Control and Drug Information Center (PCDIC), College of Medicine and Health Sciences, An-Najah National University, Nablus 44839, Palestine. 4 Clinical Research Center, An-Najah National University Hospital, Nablus 44839, Palestine.

Received: 19 June 2021  Accepted: 9 May 2022

Published online: 16 May 2022

References

1. Abdel-Latif MA. Knowledge of healthcare professionals about medication errors in hospitals. J Basic Clin Pharm. 2016;7(3):87–92.
2. Feleke SA, Mulatu MA, Yesmaw YS. Medication administration error: magnitude and associated factors among nurses in Ethiopia. BMC Nurs. 2015;14:53.
3. Escriva Gracia J, Brage Serrano R, Fernandez Garrido J. Medication errors and drug knowledge gaps among critical-care nurses: a mixed method study. BMC Health Serv Res. 2019;19(1):640.
4. Gladstone J. Drug administration errors: a study into the factors underlying the occurrence and reporting of drug errors in a district general hospital. J Adv Nurs. 1995;22(4):628–37.
5. Kuitunen S, Niittynen I, Airaksinen M, Holmstrom AR. Systemic Causes of In-Hospital Intravenous Medication Errors: A Systematic Review. J Patient Saf. 2021;17(8):e160–6.
6. Murugan S, Parris P, Wells M. Drug preparation and administration errors during simulated paediatric resuscitations. Arch Dis Child. 2019;104(5):444–50.
7. Mortaro A, Pascu D, Pancheri S, Mazzì M, Tardivo S, Bellamoli C, Ferrarese F, Poli A, Romano G, Moretti F. Reducing interruptions during medication preparation and administration. Int J Health Care Qual Assur. 2019;32(6):941–57.
8. Santomauro C, Powell M, Davis C, Liu D, Aitken LM, Sanderson P. Interruptions to Intensive Care Nurses and Clinical Errors and Procedural Failures: A Controlled Study of Causal Connection. J Patient Saf. 2021;17(8):e1433–40.
9. Wondmieneh A, Alemu W, Tadele N, Demis A. Medication administration errors and contributing factors among nurses: a cross sectional study in tertiary hospitals, Addis Ababa, Ethiopia. BMC Nurs. 2020;19(1):14.
10. Schroers G, Ross JG, Moriarty H. Nurses' Perceived Causes of Medication Administration Errors. A Qualitative Systematic Review. Jt Comm J Qual Improv. 2019;25(11):541–8.
11. Andersen PO, Maaloe R, Andersen HB. Critical incidents related to cardiac arrests reported to the Danish Patient Safety Database. Resuscitation. 2010;81(3):312–6.
12. Flannery AH, Parli SE. Medication Errors in Cardiopulmonary Arrest and Code-Related Situations. Am J Crit Care. 2016;25(1):12–20.
13. Guerrero-Marquez G, Martinez-Serrano A, Miguez-Navarro C, Lopez-Miron JA, Espartosa-Larayad M. Knowledge of nurses about medication administration errors and drug knowledge gaps among critical-care nurses: a mixed method study. BMC Health Serv Res. 2019;20(1):14.
14. Assini GA, Shebib NA, Mahmoud MA, Alouedh N, Grant E, Aljadhey H, Sheikh A. What is the epidemiology of medication errors, error-related adverse events and risk factors for errors in adults managed in community care contexts? A systematic review of the international literature. BMJ Open. 2018;8(5):e019101–e019101.
15. Ali-Worafi YM. Medication errors. In: Drug Safety in Developing Countries. edn. Cambridge: Academic Press; 2020. p. 59–71.
16. Fathi A, Hajizadeh M, Moradi K, Zandian H, Dezhkameh M, Kazemzadeh S, Rezaei S. Medication errors among nurses in teaching hospitals in the west of Iran: what we need to know about prevalence, types, and barriers to reporting. Epidemiol Health. 2017;39:e2017022–e2017022.
17. Debhan D, Debkorsi AH, Gheshtlagh RG, Kurdi A. The Prevalence of Medication Errors Among Nursing Students: A Systematic and Meta-analysis Study. Int J Prev Med. 2021;12:21.
18. Ferrah N, Lovell I, Ibrahim JE. Systematic Review of the Prevalence of Medication Errors Resulting in Hospitalization and Death of Nursing Home Residents. J Am Geriatr Soc. 2017;65(2):433–42.
19. Alsuwalla Z, Conroy S, Choonaia I. Medication errors in the Middle East countries: a systematic review of the literature. Eur J Clin Pharmacol. 2013;69(4):995–1008.
20. Marayyan MT, Al-Abyaat M, Al-Rawashdeh S, Sawalha M, Awwad M. Comparing rates and causes of, and views on reporting of medication errors among nurses working in different-sized hospitals. Nurs Forum. 2021;56(3):560–70.
21. Ali L, Safian A, Alrimawi I, Atout M. Nurses' perceptions toward factors that cause medication errors in Jordan: A qualitative study. Perspect Psychiatr Care. 2021;57(3):1417–24.
22. Al-Faouri KG, Hayajneh WA, Habboobsh DM. A five years retrospective study of reported medication incidents at a Jordanian teaching hospital: patterns and trends. Int J Humanit Soc Sci. 2014;4(4):280–7.
23. Almazrou D, Eghusosa O, Ali S, Bagalb A. Medication Misadventures Among COVID-19 Patients in Saudi Arabia. Cureus. 2021;13(6):e15153–e15153.
24. Elden NM, Ismail A. The Importance of Medication Errors Reporting in Improving the Quality of Clinical Care Services. Glob J Health Sci. 2016;8(8):54510.
25. WHO. Reporting and learning systems for medication errors: the role of pharmacovigilence centers. 2014. http://apps.who.int/medicinedocs/documents/s21625en/s21625en.pdf?ua=1. Accessed 11 Apr 2022.
26. Cullen DJ, Bates DW, Small SD, Cooper JB, Nemeskal AR, Leape LL. The incident reporting system does not detect adverse drug events: a problem for quality improvement. Jt Comm J Qual Improv. 1995;21(10):541–8.
27. Davis MA, Rake GW. Implementation of a Data-based Medical Event Reporting System in the U.S. Department of Defense. In: Henrichs K, Battles JB, Marks ES, Lewin DJ, editors. Advances in Patient Safety: From Research to Implementation (Volume 3: Implementation Issues). Rockville (MD): Agency for Healthcare Research and Quality (US); 2005.
28. Pham JC, Story JL, Hicks RW, Shore AD, Morlock LL, Cheung DS, Kelen GD, Pronovost PJ. National study on the frequency, types, causes, and consequences of voluntarily reported emergency department medication errors. J Emerg Med. 2011;40(5):485–92.
29. Bapabour A-R, Gahassab-Mozaffari N, Fathnehzad-Kazemi A. Nurses' job stress and its impact on quality of life and caring behaviors: a cross-sectional study. BMC Nurs. 2022;21(1):75.
30. Flannery AH, Parli SE. Medication Errors in Cardiopulmonary Arrest and Code-Related Situations. Am J Crit Care. 2016;25(1):12–20.
31. Guerrero-Marquez G, Martinez-Serrano A, Miguez-Navarro C, Lopez-Miron JA, Espartosa-Larayad M. Knowledge of nurses about medication doses at pediatric urgency department. Enferm Clin. 2016;26(4):213–9.
32. Chen MJ, Yu S, Chen IJ, Wang KW, Lan YH, Tang FI. Evaluation of nurses' knowledge and understanding of obstacles encountered when administering resuscitation medications. Nurse Edu Today. 2014;34(2):177–84.
33. Wittich CM, Burkle CM, Lanier WL. Medication errors: an overview for clinicians. Mayo Clin Proc. 2014;89(8):1116–25.
34. Wang X, Cheng Z. Cross-Sectional Studies: Strengths, Weaknesses, and Considerations. Curr Opin Crit Care. 2014;20(2):177–84.
35. Assini GA, Shebib NA, Mahmoud MA, Alouedh N, Grant E, Aljadhey H, Sheikh A. What is the epidemiology of medication errors, error-related adverse events and risk factors for errors in adults managed in community care contexts? A systematic review of the international literature. BMJ Open. 2018;8(5):e019101–e019101.
36. Al-Worafi YM. Medication errors. In: Drug Safety in Developing Countries. edn. Cambridge: Academic Press; 2020. p. 59–71.
37. Fathi A, Hajizadeh M, Moradi K, Zandian H, Dezhkameh M, Kazemzadeh S, Rezaei S. Medication errors among nurses in teaching hospitals in the west of Iran: what we need to know about prevalence, types, and barriers to reporting. Epidemiol Health. 2017;39:e2017022–e2017022.
38. Debhan D, Debkorsi AH, Gheshtlagh RG, Kurdi A. The Prevalence of Medication Errors Among Nursing Students: A Systematic and Meta-analysis Study. Int J Prev Med. 2021;12:21.
39. Ferrah N, Lovell I, Ibrahim JE. Systematic Review of the Prevalence of Medication Errors Resulting in Hospitalization and Death of Nursing Home Residents. J Am Geriatr Soc. 2017;65(2):433–42.
40. Yung HP, Yu S, Chu C, Hou IC, Tang FL. Nurses’ attitudes and perceived barriers to the reporting of medication administration errors. J Nurs Manag. 2016;24(5):580–8.
41. Lan YH, Wang KW, Yu S, Chen JU, Wu HF, Tang FL. Medication errors in pediatric nursing: assessment of nurses’ knowledge and analysis of the consequences of errors. Nurse Educ Today. 2014;34(5):821–8.
42. Zyoud SH, Khaled SM, Kawasmi BM, Habeeb AM, Hamadneh AT, Anabosi HH, Fadel AB, Sweileh WM, Awang R, Al-Jabi SW. Knowledge about the administration and regulation of high alert medications among nurses in Palestine: a cross-sectional study. BMC Nurs. 2019;18:11.
43. Neumar RW, Otto CW, Link MS, Kronick SL, Shuster M, Callaway CW, Kudenchuk PJ, Ornato JP, McNally B, Silvers SM, et al. Part 8: adult advanced cardiovascular life support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2010;122(18 Suppl 3):S729–767.
44. Ornato JP, Peberdy MA, Reid RD, Feeseer VR, Dhindsa HS. Impact of resuscitation system errors on survival from in-hospital cardiac arrest. Resuscitation. 2012;83(1):63–9.
45. Naome T, James M, Christine A, Mugisha TI. Practice, perceived barriers and motivating factors to medical-incident reporting: a cross-section survey of health care providers at Mbarara regional referral hospital, southwestern Uganda. BMC Health Serv Res. 2020;20(1):276.
46. Alsulami SL, Sardidi HO, Almuazni RS, Alsaif MA, Almuazni HS, Moukadem AK, Khalaf MS. Knowledge, attitude and practice on medication error reporting among health practitioners in a tertiary care setting in Saudi Arabia. Saudi Med J. 2019;40(3):246–51.
47. Mansouri SF, Mohammadi TK, Adib M, Lili EK, Soodmand M. Barriers to nurses reporting errors and adverse events. Br J Nurs. 2019;28(11):690–5.
48. Di Simone E, Giannetta N, Auddino F, Cicotto A, Grilli D, Di Muzio M. Medication Errors in the Emergency Department: Knowledge, Attitude, Behavior, and Training Needs of Nurses. Indian J Crit Care Med. 2018;22(5):346–52.
49. Alsuhebany N, Alfehaid L, Almodaimegh H, Albekairy A, Alharbi S. Attitude and Perception of Physicians and Nurses Toward the Role of Clinical Pharmacists in Riyadh, Saudi Arabia: A Qualitative Study. SAGE Open Nurs. 2019;5:2377968819889769.
50. Sheu SJ, Wei IL, Chen CH, Yu S, Tang FL. Using snowball sampling method with nurses to understand medication administration errors. J Clin Nurs. 2009;18(4):559–69.

Publisher’s Note
Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.