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Investigating prescribing errors in the emergency department of a large governmental hospital in Jordan

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Abstract

Background Although prescribing errors (PEs) are the most common type of medication errors and cause morbidity and mortality, they have been rarely studied.
Objective The study aimed to investigate PEs incidence, types, severity, causes, predictors, pharmacists' interventions accepted by doctors and computer-related errors.
Setting This study was conducted in the emergency department of the largest governmental hospital in Jordan.
Method This was a retrospective observational 4-week study. A validated definition of PEs was adopted, and errors were identified by direct observation of all prescriptions. Structured interviews with doctors to assess the causes of errors were conducted within three days of the prescription date; the severity of PEs was rated by a committee.
Main outcome measure Prescribing errors incidence, types, severity, causes, predictors, pharmacists' interventions accepted by doctors and computer-related errors.
Results For 1330 patients, 3470 medication orders were recorded. Almost one in five patients had PEs (n = 288, 21.65%), and the total number of medication orders for patients who had errors was 610. The PEs incidence was 12.5% (95% CI 11.4%–3.5% (n = 450/3597)). Analgesics were the most common medications associated with PEs (232/610, 38.03%). The top two types of PEs detected were wrong drug (165/450, 36.6%) and wrong dose (142/450, 31.5%) respectively. Most PEs were clinically significant errors (342/450, 76%). Doctors refused pharmacists' interventions on their orders in 132 (45.8%) prescriptions. The most common cause of errors was poor skills of doctors in electronic prescribing system (266/450, 59%). Predictors of PEs were the following: drug with multiple dosage forms (OR 2.998; 95% CI 1.41–6.34; P = 0.004) and a prescription with polypharmacy (OR 1.685; 95% CI 1.25%–2.26%; P = 0.001).
Conclusion A national approach for observing, intervening on and correcting PEs is necessary to improve patient safety.
Keywords health policy; health services research; pharmaco-economics

Impact on practice

- Pharmacists in the emergency department have a pivotal role in identifying and correcting prescribing errors (PEs) before they harm patients.
- Improving pharmacists' interpersonal skills, to collaborate with physicians and manage conflicts about prescriptions.
- Encouraging reporting of PEs by an official approach will allow greater understanding of patterns of errors in hospital setting.
- Training workshops are needed for doctors in the emergency department to improve their skills on electronic prescribing systems.

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Introduction

A Medication error (ME) is 'a failure in the treatment process that leads to, or has the potential to lead to, harm to the patient'.[1] A prescribing error (PE) is one of the most encountered MEs in hospitals, and as all MEs, it considered to be preventable.[2,3] A PE can be defined as 'a clinically meaningful prescribing error occurs when – as a result of a prescribing decision or prescription writing process – there is an unintentional significant reduction in the probability of treatment being timely and effective or increase in the risk of harm when compared with generally accepted practice'.[2] This definition reflected the distinction, including failures both in the prescribing decision and in the prescription writing process. However, the reported rates of PEs vary greatly due to the plethora of PE definitions, multiple data collection methods and varying study settings.[4,5] Many studies were conducted to improve PEs severity evaluation tools and to assess the impact of electronic prescribing system (EPS) on occurrence of PEs.[6,7]

In a hospital-based systemic review, it was found that PEs are common, affecting half of hospital admissions, whereas it only affects 7% of medication orders and 2% of patient days.[8] In Saudi Arabia, PEs incidence ranged from 7.1 to 94% of prescriptions.[9] A UK study conducted in hospital with electronic prescribing system (EPS) showed that PEs incidence at hospital discharge was 8.4%.[10]

It has to be known that PEs can occur in any medical or surgical speciality. However, the Institute of Medicine report 'To Err is Human: Building a Safer Health System' stated that the emergency department (ED) setting accounts for a large number of medical errors.[11] A US study showed that PEs were the most predominant medication errors in the ED.[12] Other studies in the paediatric ED setting have found that as many as 10% of medical charts contained PEs.[13] The ED is vulnerable to MEs due to clinicians providing episodic care to patients in an emergent or urgent situation often without support from the pharmacy team. Periods of overcrowding, nursing shortages, and scarcity of hospital beds along with frequent handovers, multitasking and frequent interruptions result in a high-stress clinical setting.[14] Approximately 3% of all hospital-related adverse events occur in the ED.[15] Therefore, MEs, particularly PEs, are expected to occur frequently in high incidence in hospitals' EDs in Jordan.

Aim of the study

The study aimed to investigate PEs incidence, types, severity, causes, predictors, pharmacists' interventions accepted by doctors and computer-related errors.

Method

Study design

This study was a cross-sectional recently retrospective study in the ED of the largest governmental hospital in Jordan. The research team (a research pharmacist and a senior pharmacist working in the hospital) observed and detected PEs within 1–3 h of medications being prescribed. The study had two methods, direct observation for detecting PEs and structured interviews to investigate possible PE causes, and estimate the acceptance of pharmacists' interventions by the ED doctors.

Definitions and equations

Dean Franklin's definition and classification of PEs was adopted[2] (Table 1). Overhage's severity scale (Table 2) was used by the committee which evaluated the severity of PEs.[16] In addition, PEs incidence equations were adopted from Abdel-Qader's paper.[10]

Setting and participants

The study was conducted in a 33-bed ED of Al Bashir Hospital, where more than 400 patients per day received health care. There were three rotating shifts in the ED per day, and the total number of ED doctors was 39. They were either general practitioners or ED specialists. The total number of pharmacists at the ED was eight. Most of the pharmacists had 3–5 years' experience in hospitals, and none of them was a clinical pharmacist. Life-threatening cases were excluded in our study due to the insufficient number of researchers covering the overcrowded emergency department, and also the difficulties

Table 1 Prescribing errors classification[3]

Error in decision-making:	
Wrong drug	1 – Prescribing a drug for a patient for whom, as a result of a co-existing clinical condition, that drug is contraindicated 2 – Prescription of a drug to which the patient has a documented clinically significant allergy 3 – Prescribing a drug for which there is no indication for that patient
Wrong dose	1 –When the quantity of medicine recommended to be taken at a particular time is incorrect 2 – Prescribing a drug in a dose that, according to British National Formulary or data sheet recommendations, is inappropriate for the patient's renal function
Wrong frequency	When the prescribed frequency of medicine is different from current evidence-based treatment guidelines
Wrong dosage form	When a dosage form is not intended by the prescriber is written in the prescription, or when a dosage form is not available for that drug is prescribed.
Omission	Omissions: Missing elements that will require further information. • Major omissions would require the pharmacist to contact the prescriber. Minor omissions may be filled by the pharmacist based on professional judgement and/or additional information gathered from the parent or prescriber

Table 2 The severity of prescribing errors[12]

Lethal error	High potential for life-threatening adverse effects/ reactions
	The potentially lifesaving drug at a dosage too low for the disease being treated
	High dosage (>10 times normal) of a drug with a low therapeutic index
Serious error	Route of administration could lead to severe toxicity
	A low dosage of a drug for serious disease in the patient with acute distress
	High dosage (4–10 times normal) of a drug with a low therapeutic index
	Dosage resulted in serum drug concentration in the potentially toxic range
	The drug could exacerbate the patient's condition (related to warnings or contraindications)
	Documented allergy to a drug
	High dosage (>10 times normal) of a drug without a low therapeutic index
Significant error	High dosage (1.5–4 times normal) of a drug with a low therapeutic index
	Drug dosage too low for patient's condition
	High dosage (1.5–10 times normal) of a drug without a low therapeutic index
	Errant dual-drug therapy for a single condition
	Inappropriate dosage interval
	Omission from the medication order
Minor error	Incomplete information in the medication order
	The unavailable or inappropriate dosage form
	Non-formulary drug
	Non-compliance with standard formulations and hospital policies
No error	Information or clarification requested by the physician or other healthcare professional from the pharmacist
	Cost savings only

in being granted access to such highly charged and challenging situations. Non-life-threatening cases were registered in three medical clinics that contained nine doctors. There were three doctors for every 8-h shift. In these clinics, doctors diagnosed patients and wrote prescriptions on the electronic prescribing system (EPS), 'Hakeem©'. By the patients ID number, the pharmacist received and dispensed each prescription. The types of electronic medical information clinicians may access included, but were not limited to, the following: comprehensive medical and surgical history, physical examinations, procedural and surgical reports, current medications, allergies, and inpatient and outpatient clinic visit notes. In addition, it provided online access to laboratory results, digital radiological examinations, electrocardiograms (ECGs), endoscopic biopsies, eye examinations, and videos of echocardiograms and angiograms. However, Hakeem did not include clinical decision support system (CDSS).

Inclusion criteria

- All ED patients who were classified as non-life-threatening cases or injuries during the study period.

Exclusion criteria

- Patients from other wards who came to the ED pharmacy to dispense their medications in special cases.

Piloting

A small-scale preliminary study was conducted in order to evaluate feasibility, time and practicality prior to conduct the full-scale research project. Piloting was conducted in the ED for 5 days. Many operational definitions were removed, and others were added after piloting. In addition, PEs reporting form was edited, and the research period was confirmed.

Data collection

Data collection was done by disguised direct observation in the ED pharmacy during patients ED visit, and it was conducted during the morning shift (8:00 a.m.–4:00 p.m.), the evening shift (4:00 p.m.–12:00 a.m.) and the night shift (12:00 a.m.–8:00 a.m.). The research team detected PEs within 1–3 h of medication being prescribed. In order to avoid the Hawthorne effect during the PEs detection period, doctors were unaware of the study objectives. The research team used a standardised PE reporting form to identify errors and categorise it.

Data analysis

Raw data were entered and tabulated using the Statistical Package for Social Science (SPSS) software V20.

Physician's interview

Within 3 days, doctors who committed errors were interviewed; a structured interview form was used with closed-ended questions about the acceptance of pharmacist's interventions and the possible causes of the PEs detected (including decision-making and process of prescriptions entering into computer).

Prescribing errors severity

Prescribing errors severity was assessed by multidisciplinary committee: an independent senior paediatrician, senior clinical pharmacist (DAQ) and the research pharmacist (AAM), who reviewed clinical information, such as drug selection, dose, frequency, duration, hypersensitivity, contraindication and microbiology investigation results (including antibiotic susceptibilities of any identified pathogens) against the British National Formulary (BNF; 74th edition) and Overhage's severity scale. Any disagreement was solved by discussion.

Interrater reliability

The Kappa statistic was used to test interrater reliability. Value of kappa below 0.5 was considered as bad reliability, above 0.5 and below 0.7 moderate reliability, above 0.7 good, and above 0.8 great reliability.[17]

Computer-related errors (CREs)

Based on the interviews with physicians which displayed the causes of errors, the committee classified errors them into CREs and non-CREs.

Predictors

Predictors were studied on three consecutive days; data were collected during this period for seven independent variables compiled from the literature, and eventually selected based on the available demographic and medical information of patients, which are the following: patient's characteristics (patient's age and gender), prescriber's characteristics (physician's specialty) and drug characteristics (number of drugs ordered, time of prescription, availability of multiple drug dosage form). PEs occurrence was considered the dependent variable. Data were tabulated using SPSS V20 software. Multivariate logistic regression test was conducted to determine PEs predictors.

Multicollinearity test

Multicollinearity is a statistical measure in which two or more predictors variables in a multiple regression model are highly correlated. If there is no linear relationship between predictor variables, they are said to be orthogonal or uncorrelated.[18] To ensure accuracy of regression analysis results, guidelines state that the threshold for multicollinearity probability is variance inflation factor = 3. If it is >3, it will be problematic.

Reference: The research team used the British National Formulary (BNF; 74th edition) as a reference for medication doses, frequency and dosage forms.

Incidence equations

Derar Abdel-Qader's[10] formulas were adopted to calculate six types of incidence. The incidence of patients with error was calculated by dividing the number of patients prescribed an erroneous order by all discharged patients on the day of data collection. The incidence of erroneous orders was the number of medication orders with an error divided by the total number of orders recorded plus those omitted in error. The incidence of omission errors (number of omission errors divided by orders recorded), incidence of commission errors (number of commission errors (i.e. PEs without omission errors) divided by orders recorded) and incidence of PEs relative to the opportunities for error (PE incidence divided by four) were also calculated. Each medication order had four opportunities for error (drug name, dose, frequency and formulation.[10]

Results

Overview of the study data

For 1330 patients, 3470 medication orders were recorded. More than one-fifth of the patients had PEs (n = 288, 21.65%), and the total number of medication orders for patients who had errors was 610. Patients who had errors had 430 erroneous orders and 450 PEs.

Demographic characteristics of patients with errors

The mean of patients' age was 20.1 (SD = 18.1). The mean number of medication orders was 2.1 (SD = 1.1) per patient. The total number of erroneous orders was 430, with 450 PEs.

Patients' chief complaints

Doctors wrote 45 different diagnoses for presenting patients, and these diseases were classified. The results showed that the most frequent disorder was GIT disorder (101/288, 35.1%), infection (64/288, 22.2%) and respiratory disorder (37/288, 12.8%), and the least frequent diagnosis was haematological disorder (3/288, 1%).

Medication characteristics

As shown in Figure 1, analgesics were the most common medications prescribed for patient with errors (232/610, 38.1%), whereas expectorants and antidepressants were the least medications prescribed (2/610, 0.3%) and (2/610, 0.3%) respectively. Most of medications were orally administered (529/610, 86.5%), with multiple dosage forms (502/610, 82.3%).

Prescribing errors incidence

As Table 3 shows, the cumulative incidences of patients with error and erroneous orders were 21.67% (95% CI 19.38–23.81 (n = 288/1330)) and 11.95% (95% CI 10.8–12.95 (n = 430/3597)) respectively. The PEs incidence was 12.5% (95% CI 11.4–13.5 (n = 450/3597)).

Prescribing errors types and their frequency

Wrong drug was considered as the most common type of PEs, in more than third of the cases (165/450, 36.67%). The least common one was wrong frequency (1/450, 0.22%).

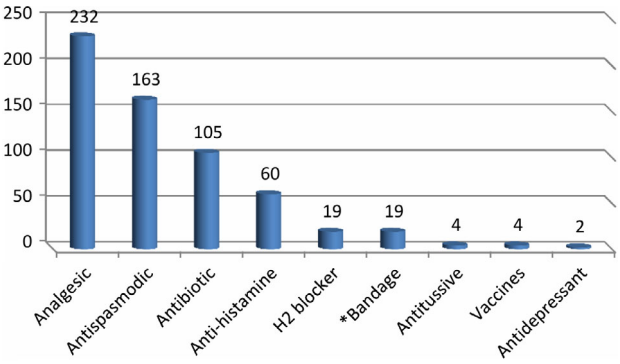

Figure 1 Characteristics of prescribed medications for patients with errors.

Table 3 Prescribing errors (PEs) and interventions incidence

Code	Parameter	Equation	Value	95% CI
A	Total number of patients during the study		1330	
B	Total number of medication orders		3470	
C	Total number of omission errors		127	
D	Total number of patients with errors		288	
	The total number of medication orders:			
E	One prescribing error		410	
F	Two prescribing errors		18	
G	Three prescribing errors		2	
I	Total number of erroneous medication orders intercepted by pharmacists	E + F + G	430	
J	Total number of prescribing errors	E + 2F + 3G	450	
K	The total number of interventions not associated with prescribing errors		17	
L	Total number of clinical interventions		467	
M	Cumulative incidence of patients with error	(D/A) × 100%	21.67%	19.38–23.81%
N	Cumulative incidence with prescribing errors	J/(B + C) × 100%	12.5%	11.4–13.5%
O	Cumulative incidence of erroneous orders	I/(B + C) × 100%	11.95%	10.8–12.95%
P	Cumulative incidence of omission errors	(C/B) × 100%	3.66%	3.035–4.28%
Q	Cumulative incidence of prescribing errors without omission errors	{(J−C)/B} × 100%	9.3%	8.3–10.2%
R	Cumulative incidence of prescribing errors versus opportunities for errors	J/4(B + C) × 100%	3.127%	2.81–3.38%

The severity prescribing errors

The results have shown that most of the errors detected were significant errors (342/450, 76%), minor errors were (89/450, 19.8%) and serious errors (19/450, 4.2%).

Interrater reliability of prescribing errors severity

The results showed strong reliability ($K = 0.874$), and it was a significant result ($P < 0.05$). Raters' judgments were close to each other by 87% agreement. Therefore, the consistency between raters was excellent.

Computer-related errors (CREs)

The results showed that 347 (80.6%) of erroneous orders were not related to the electronic system used in the prescribing process, whereas 83 (19.4%) of erroneous orders were CREs.

Predictors of prescribing errors

As shown in Table 4, predictors of PEs were the following: drug with multiple dosage forms (OR 2.998; 95% CI 1.41–6.34; $P = 0.004$) and a prescription with polypharmacy (OR 1.685; 95% CI 1.25–2.26; $P = 0.001$). The results showed no chance for multicollinearity (all VIFs < 3.00).

Multicollinearity test

The results (Table 5) showed no chance for multicollinearity (all VIFs < 3.00), and our regression analysis process was accurate and specific.

Causes of prescribing errors

Causes of PEs according to doctors were the following: poor skills of doctors in EPS (266/450, 59%), low staff number (108/450, 24%) and work overload (76/450, 16.8%).

Doctors' acceptance of pharmacists' interventions

Out of 1330 patients, pharmacists' interventions were noted in 288 patients. Doctors accepted pharmacists' corrective actions in more than half of prescriptions ($n = 156$, 54.2%). Doctors refused pharmacists to intervene on their orders in 132 (45.8%) prescriptions.

Table 4 Prescribing errors predictors (n = 224)

Category	Predictors	Odds ratio	*P* value	95% CI for odds	
				Lower	Upper
Patient characteristics	Patient age	0.999	NS	0.984	1.014
	Patient gender(male)	1.166	NS	0.647	2.103
Prescriber characteristics	Specialty	0.378	NS	0.146	0.976
	Doctors' status(junior)	0.709	NS	0.276	1.817
Drug characteristics	**Number of orders**	1.685	0.001	1.252	2.268
	Time (shift A)	1.126	NS	0.137	9.264
	Dosage: (Multiple dosage form)	2.998	0.004	1.417	6.343

Table 5 Multicollinearity test

Model		Collinearity statistics	
		Tolerance	VIF
1	Specialty	0.448	2.231
	Physician status	0.444	2.254
	Number of order	0.772	1.296
	Time(1,1,2,2)	0.980	1.020
	Dosage frequency	0.845	1.184
	Number of errors in the prescription	0.812	1.232
	Patient age	0.863	1.159

a. Dependent variable: patient gender

Discussion

This was the first study to investigate the incidence, types, severity, causes and predictors of PEs in the ED of a large governmental hospital in the Middle East. The most important advantage of this technique is that the research pharmacist was able to ask doctors about each error whilst fresh in the mind of the prescriber.

Our study had two major limitations. Firstly, it was carried out in the ED of one governmental hospital. Therefore, the results could not be easily generalisable. Different hospitals have different conditions, staff and locations. However, most of the governmental hospitals in Jordan have the same organisational processes in the ED. Secondly, this study excluded life-threatening cases from the investigation. Thus, lethal errors were not detected in this study.

Our results showed that PEs cumulative incidence was 12.5%. Cumulative incidences of patients with error and erroneous orders were 21.67% and 11.95% respectively. PEs incidence was considered to be high, because doctors were poorly skilled in using EPS 'Hakeem'. Although a formal statistical comparison is not possible, our results showed higher PEs incidence compared to other studies conducted in the ED; 3.2%,[13] 3.7%,[14] 6.2%[4] and 9.9%.[19] On the other hand, other studies showed higher PEs incidence than ours, 16 and 13.2%.[20] PEs incidence on discharge was 8.4%.[10] Both methodological approaches and geographic locations might have contributed to the variation in PEs incidence. Moreover, ambiguous definitions of PEs created high level of uncertainty when comparing studies.

Our results showed that the most common medications associated with PEs were analgesics (232, 38.03%) and the least medication classes associated with PEs were antidepressants (2, 0.3%) and expectorants (2, 0.3%). The results were consistent with the services sought by the patients during the study. As most of the patients suffered from acute pain due to headache, severe toothache, backache and injuries due to accidents. On the other hand, psychiatric disorders are rarely managed in EDs in Jordan.

The results in this study were consistent with those shown in a prospective study in the ED[13] and in a retrospective study on hospital discharge.[10] However, cardiovascular medications (21, 21.2%) were the most common medication class associated with PEs in the ED[13] and in hospital inpatients.[5,21] The admission stage and geographic location of hospitals contributed to the variation in medications associated with PEs among different studies.

This study results have shown that most common PEs types were wrong drug (165, 36.6%) and wrong dose (142, 31.5%), whereas wrong frequency (1, 0.23%) was far less common. Most wrong drug errors were CREs. Doctors wrongly selected a drug from the drop down menu. Also, to a lesser extent, wrong dose PEs were CREs.

Doctors who lacked skills in using EPS and the absence of training contributed to our results. In addition, the absence of clinical decision support system (CDSS) in the EPS had a considerable effect on increasing the rate of PEs. CDSS has the power to reduce toxic drug levels, reduce medical errors, change prescribing in accordance with guideline recommendations and reduce time to achieving therapeutic control. Moreover, CDSS can prevent prescribing of drugs that cause allergic reactions.[22]

Our results were consistent with that shown in a prospective study conducted in the ED, where the wrong dose accounted for one of the most common PEs detected.[13] In contrary to our findings, omission of medications was the most frequent error, as it was (31%) and (28.5%) of the cases in hospital discharge and in hospital inpatient respectively.[5,10] Other studies showed different results compared to our findings. For instance, drug–drug interaction and wrong frequency were the most frequent errors with (68.2%) and (12%), respectively, in a study carried out in India.[21] It is obvious that PEs types in the ED were different from other wards. The overcrowded environment in the ED might have caused the difference in PEs types.

Our study relied on a committee for PEs severity categorisation. Most of the errors detected were significant errors 342 (76%), minor errors were 89 (19.8%), and serious errors showed 19 (4.2%) errors. Lethal errors were absent from our findings.

A UK study has evaluated the errors in a similar way as what has been done in this study; there were 18 (2.9%) serious, 481 (76.3%) significant and 131 (20.8%) minor erroneous orders.[10] Our results showed that 347 (80.6%) of erroneous orders were not related to the electronic system used in the prescribing process, whereas 83 (19.4%) of erroneous orders were CREs. However, global studies showed a greater negative effect of EPS on the prescribing process. There were 279 (44.3%) erroneous orders rated as CREs in a study conducted in the UK.[10] However, EPS with electronic medication alert system was associated with a decrease in overall PEs in a paediatric emergency department.[23] Another study showed an unexpected increase in mortality coincident with EPS implementation.[24]

The results showed that doctors' poor skills in EPS (266, 59%) and low staff number (108, 24%) were the most frequent causes of PEs, whereas work overload accounted for 17% (76) of causes. In Scotland, results from interviews with prescribers stated that error causation was multi-factorial; work environment and team factors were particularly noted. Other possible causes of PEs were presented by Bryony Dean. PEs was made because of slips inattention, or because prescribers did not apply relevant rules.[25,26]

Our results suggested that predictors of PEs were prescriptions that contained drugs with multiple dosage forms which were almost three times more likely to have a PE than prescriptions that contained drugs with single dosage form and prescriptions with polypharmacy were 1.6 times more likely to have a PE than prescriptions with a single medication order. Consistent with our results, prescriptions with polypharmacy were found to be a significant predictor in the ED.[13,27]

This study emphasised the importance of pharmacists' interventions in the ED. However, doctors refused pharmacists to intervene on PEs in 45.8% of the patients with errors. It is important to improve pharmacists' interpersonal communication skills to manage these types of conflicts among medical staff to overcome this gap.[28] The ED doctors claimed that pharmacists were not qualified in Jordan to intervene on or to correct errors during the prescribing process. Moreover, many doctors underestimated the potential consequences of PEs intervened by pharmacists; this calls for studies investigating the PEs-related adverse events in Jordan. Other studies conducted in the UK and Egypt showed general acceptance of pharmacists' interventions,[29,30] whereas in Iraq two-thirds of pharmacists' interventions were refused.[31]

Conclusion

Prescribing errors occurred frequently in the ED of the largest governmental hospital in Jordan. Our results highlighted the vital role of pharmacists to intervene on PEs in the ED. Furthermore, CDSS should be implemented to enhance the safety of the EPS. Policymakers should initiate efficient and valid approaches to encourage PEs identifying and reporting.

Declarations

Conflict of interest

The Author(s) declare(s) that they have no conflicts of interest to disclose.

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Authors' contributions

Derar H. Abdel-Qader developed the study design, collected the data, and participated in data analysis, Ahmad Z. Al Meslamani performed the data collection, analysis, and first draft of manuscript, Asma' A. El-Shara' did the literature review and polishing the manuscript, Najlaa Saadi Ismael participated in data analysis, Abdullah Albassam drafted the manuscript and improvement, Penny J. Lewis was responsible for writing and language improvement. Salim Hamadi assisted in data collection and method development, Hazim Saleem Abbas participated in data collection and analysis, Nadia Al Mazrouei participated in study design development and data analysis. Osama Mohamed Ibrahim supervised data analysis and reviewed the drafted manuscript and improved it.

Ethics approval

The study was approved by the Ministry of Health in Jordan, the Administrative Committee of Al Bashir Hospital (no. 9693) and the Institutional Review Board (IRB) at the University of Petra (no. 3H-7-2018).

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