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Organization factors influencing nurse ability to prevent and detect adverse drug events in public hospitals using a patient safety model

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ABSTRACT

The objective of this study was to measure organization factors that can influence the ability of nursing staff to prevent and detect ADEs in public hospitals using Systems Engineering Initiative for Patient Safety (SEIPS) model.

Methods: This was a multi-center cross-sectional study. The study included a self-administered paper-based survey which was distributed and collected between October through December 2019. The study participants were nurses from 11 public hospitals located in two Iraqi provinces. Binary logistic regression was used to measure the relationship between the independent SEIPS factors (persons, organizations, tools, tasks, and environments) and the incidence of ADEs (outcome variable).

Results: The study recruited 603 nurses (68.3% men) from 11 public hospitals across two provinces. Less than half (48.8%) of the nurses received enough training to detect ADEs, 43.1% had adequate experience to detect ADEs, and 69.8% had to report ADEs in a special record. More than three-quarters (78.4%) believed that their jobs need fast work. Two of the five SEIPS model domains had significant negative association with the incidence of ADEs including organization (nurse-physician collaboration) and nurse experience in ADE detection.

Conclusions: Nursing staff face several challenges to prevent and minimize ADEs including shortages in nurses, inadequate nurse experience in ADE detection, no training for ADE detection was received, fear of reporting ADEs, and a lack in monitoring equipment. Increasing nurse/patient ratio and providing more monitoring equipment and training courses can minimize ADEs and enhance their detection.

1. Introduction

According to the US Office of Disease Prevention and Health Promotion (ODPHP), adverse drug events (ADEs) cause two million hospital admissions and one million emergency room admissions annually (Montané and Santesmases, 2020).

Medications are administered by healthcare facilities all over the world. The sizable and massive increase in the consumption of medications causes an increased incidence of ADEs (Duerden and Payne, 2013; Scott, 2016). ADEs can be defined as unintentional injuries that may take place at any therapeutic concentration and can be harmful and require hospitalization (Al-Jumaili and Doucette, 2018; Handler et al., 2006). ADE is an umbrella term that

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includes both adverse drug reactions (ADRs) and medication errors (MEs) (Anathhanam et al., 2012; Cresswell et al., 2007). A medication error (ME) is either a reduction in the effectiveness or an escalation in the risk of harm during treatment (i.e. mistake in the treatment process that result in or has the possibility to cause patient harm (Dean et al., 2000; Ferner and Aronson, 2006).

ADEs are common and may produce substantial morbidity and mortality in addition to their economic cost associations (Anathhanam et al., 2012). For instance, Iraqi Pharmacovigilance Center (IqPhvc) received 2,344 ADE reports from 2014 to 2020 for patients<18 years old. Approximately half of ADEs happened due to MEs and the other half was due to ADRs (Jawad et al, 2020). A study in UK found that 12% of primary care patients are exposed to ADEs through prescribing or monitoring errors annually (Avery et al., 2012). This percent increased to 38% among elderlies and 30% among patients with polypharmacy who are taking five or more medications (Avery et al., 2012; Scott, 2016).

Nurses are considered essential healthcare practitioners in hospitals. One of the major tasks of nurses is administering medications to patients. Thus, they should be aware of the importance of proper recognition and administration of medications to avoid potential complications resulting from MEs (Morales-González and Galiano Gálvez, 2017; Shohani and Tavan, 2018).

Nursing staff knowledge of high-risk medications is critical to prevent and detect ADEs. Other potential factors influencing ADE incidence include nurses' high workload, time pressure, experience, and interruptions during medication preparation and administration, which may increase ME rates (Al-Jumaili and Doucette, 2018).

The Systems Engineering Initiative for Patient Safety (SEIPS) model was developed in 2006 to assess the effect of the work system on health outcomes (Al-Jumaili and Doucette, 2018; Carayon et al., 2006). The five domains of work system include persons (e.g. healthcare practitioner), organizations, tools, tasks, and environments. In 2017, the SEIPS model was used to assess medication safety in nursing homes (Al-Jumaili and Doucette, 2018). In 2019, this study implemented the SEIPS model to derive potential factors influencing ADEs in public hospitals. Thus, the survey items follow the five main domains of the SEIPS work system (Fig. 1).

The objective of this study was to measure organization factors that can influence the ability of nursing staff to prevent and detect ADEs in Iraqi hospitals using SEIPS model.

2. Methods

2.1. Study design and participants

This was a multi-center cross-sectional study. The study included a self-administered paper-based survey which was distributed and collected between October through December 2019. The study participants were nurses from 11 public hospitals locating in two Iraqi provinces, Baghdad and Babylon

2.2. Survey questionnaire

The variables of the five SEIPS model domains were adopted from Al-Jumaili and Doucette study (2018) about system factors influencing medication safety in nursing homes (Al-Jumaili and Doucette, 2018). The survey mainly included close-ended questions and a couple of open-ended questions (for experience years and years in the ward). The survey consisted of three sections. The first part included seven nurse characteristics. The second part included eight items about the role of the nurses and routine hospital monitoring, detecting, reporting, and treating ADEs. The outcome variable is the incidence of ADEs in the last week (yes vs. no). The last section representing the five domains of the SEIPS model consists of 17 items with 5-point Likert scale (from strongly disagree to strongly agree).

To eliminate the language barrier, the survey was translated to formal Arabic by the authors and the translation was validated by two bilingual native Arabic scholars. Content validity was conducted by experts in the field. Furthermore, internal consistency was conducted via measurement of Cronbach' alpha for the items representing each domain of the SEIPS model. The survey was

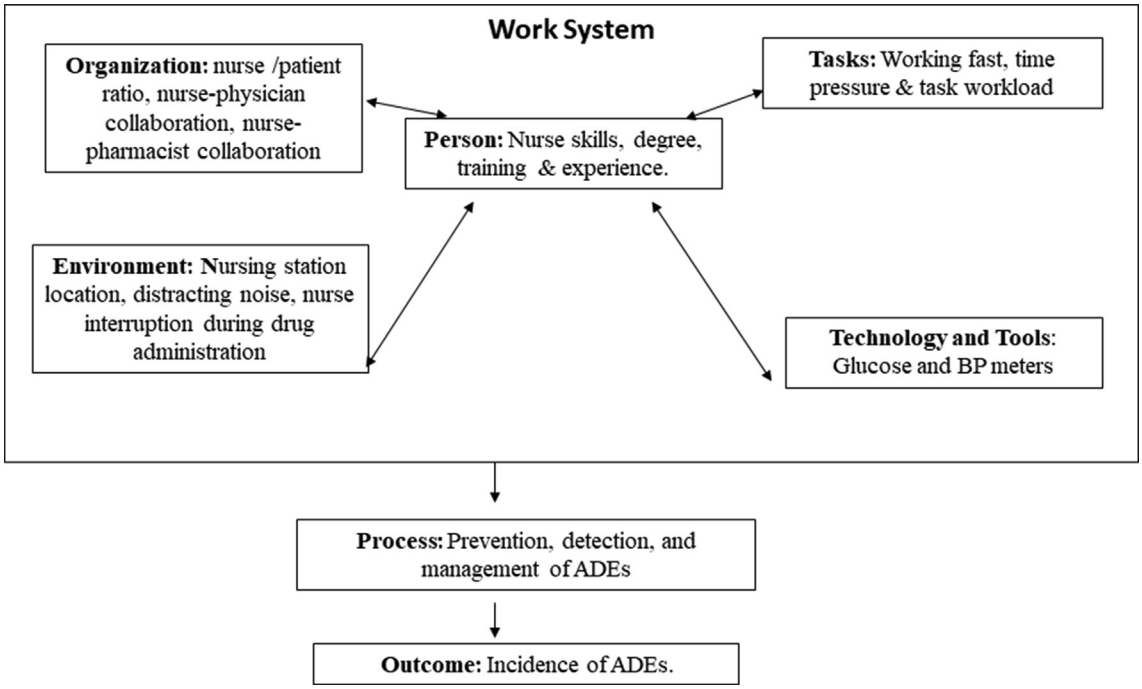

Fig. 1. SEIPS model for ADEs prevention and detection in hospitals.

pretested in a pilot study with 40 nurses working in five public hospitals and those participants were excluded from the final analysis. Appropriate revisions were conducted according to the pilot study feedback. The criteria for the participants in the survey was that they had to be nursing staff working in public hospitals.

2.3. Data collection

The 11 hospitals were selected purposefully as the main public hospitals in the two participating provinces. Three researchers (a pharmacist and two last-year pharmacy students) approached all nurses working in public hospitals (census sampling) and asked if they were willing to complete the survey. Subsequently, nurses who gave verbal consent were provided a two-page paper survey, which the authors collected in-person. Medical assistants were also included in the survey since they have similar roles to nurses. The research team distributed the paper-survey in person during both morning and evening shifts and waited until participants filled it out. They did not measure the response rate because they were unaware of the total number of nurses in each hospital. In general, most nurses who were available at the time of the researcher visits were cooperative and agreed to participate.

The privacy and confidentiality of the participants were assured, and the survey was voluntary and anonymous. Verbal consent was obtained from the participants before distributing the survey. No incentive was offered to the participants. The study proposal was approved by the Ethical Committee at the University of Baghdad College of Pharmacy before starting data collection.

2.4. Statistical analyses

The data analyses were performed utilizing the Statistical Package for the Social Sciences (SPSS, Chicago, IL) Program for Windows, version 22.0. Means, frequencies, and percentages of participant characteristics were calculated. Binary logistic regression was used to measure the relationship between the independent SEIPS factors and the outcome variable (incidence of ADEs). The statistically significant value was p-value < 0.05.

3. Results

The researchers collected 603 completed paper surveys from 21 wards at 11 public Iraqi hospitals across two provinces (Baghdad and Babylon). The hospitals' number of beds ranged from 103 to 560 with an average of 236.2 (±145.5) beds. The participating nurses had different positions and practice years (Table 1).

3.1. Characteristics of participating nurses

The characteristic items showed that about two-thirds (68.3%) of the nurses were men. Forty-two percent had graduated from nursing high school, 36.7% had two-year diploma and only 21.4% completed bachelor's degree in nursing. They had at least six months of nursing practice experience and one month in the current ward. The dominance job title was skilled nurse (36%) and two-thirds worked in morning shift (68.8%) (Table 1).

3.2. Nurse role in preventing, identifying, and reporting ADEs

One of the nurse roles in preventing, monitoring, and detecting ADEs is measuring blood pressure (BP) where BP was mostly checked twice daily (34.8%) for hypertensive patients according to physician orders (Table 2). The answers showed that majority of the nurses (83.6%) had to report any ADEs while more than half (53.9%) did not detect serious ADEs last month. Ninety-one percent of nurses thought that they should contact a doctor if any ADEs detected while 20.2% chose to inform a pharmacist, and 22.7% chose to treat ADEs themselves. More than two-thirds (69.8%) of the participating nurses had to report ADEs in a special record while 88.9% reported that they rarely had medication discrepancies in their ward. Less than half of the nurses (44.1%) detected ADEs in the last week and 26.2% were fearful of reporting ADEs.

3.3. SEIPS model findings

This section of the survey shows the characteristics of hospital conditions and environments in addition to the nurse roles in preventing and detecting ADEs. Firstly, more than half of the nurses (57.2%) agreed that they had enough time to detect ADEs (Table 3). The majority (69.3%) agreed that they could measure vital signs accurately. More than a third of the nurses had not received adequate training to identify ADEs, nor had the experience required to detect ADEs. Less than half (48.8%) received enough training to detect ADEs. Additionally, 43.1% agreed to have adequate experience to detect ADEs. More than three-quarters (78.4%) believed that their job needs fast work (Table 3).

About three-quarters agreed that physicians and clinical pharmacists were ready to answer their questions about prescribed medication. More than half (62.5%) agreed that they have good collaboration with doctors. The nurse room location was close to patient rooms, according to majority of the participants (69.3%); thus, nurses could quickly reach them.

Approximately 42% of the participants agreed that there is an interrupting noise in their units. A large percentage (63.2%) agreed that they have too much work to do. Half of the nurses confirmed that they had been interrupted during their medication administration task. According to 40.2% of the participants, the hospitals did not have enough number of glucose meters.

More than half (58.9%) of the nurses had good communications with patients about medication concerns. Over than half of the nurses (65.6%) confirmed that preventing ADEs was one of their hospital's priorities. On the other hand, 34.1% of the participants reported an inadequate number of BP meters in their wards. Finally, 40.8% indicated inadequate number of nurses in their ward.

Binary logistic regression was used to measure the association between the outcome variable (incidence of ADEs) and nine independent variables: five of the SEIPS model and four demographics (gender and experience period in the ward) and job characteristics (shift time and availability of ADE reporting system). Two out of the five SEIPS model domains were significantly related to the incidence of ADEs in the hospitals including organization (interdisciplinary collaboration) and personal characteristics (experience) of the nurses. There is a significant negative (Odds Ratio, OR = 0.83, P-value = 0.022) association between adequate nurse experience and the incidence of ADEs. In other words, longer nurse experience for detecting ADEs is associated with lower ADE incidence rates. Similarly, there is significant negative (OR = 0.84, P-value = 0.046) association between nurse-physician collaboration and the incidence rate of ADEs (Table 4). Higher interprofessional collaboration is associated with lower rate of ADEs. Finally, According to Chi-square analysis, the reported ADEs are more common among healthcare settings having nurses who do not fear ADE reporting (Table 5). The internal consistency of most of the five SEIPS scale was acceptable (Table 6).

4. Discussion

One of the most important contributions of this study is that it comprehensively inspected individual and system factors that may influence the nurses' abilities to prevent and detect ADEs. Using

Table 1
The characteristic of participating nurses.

Factor	Sub-category	Frequency (N)	Percent (%)	
Gender	Male	412	68.3	
	Female	191	31.7	
Hospital Province	Baghdad Hospitals	397	65.8	
	Babylon (Hilla) hospitals	206	34.2	
Academic Degree	BSc Degree	129	21.4	
	Diploma	221	36.7	
	Nursing School	253	42.0	
Job title	Skilled Nurse	220	36.5	
	Technical Nurse	164	27.2	
	University Nurse	112	18.6	
	Nurse's Chief	66	10.9	
	Medical Assistant	41	15.9	
Types of Ward	Cardiology	20	3.3	
	ICU	39	6.5	
	Emergency	47	7.8	
	Fracture	43	7.1	
	Gynaecology	48	8.0	
	Internal	95	15.8	
	Paediatric	26	4.3	
	Premature infant	38	6.3	
	Surgery	156	25.9	
	Others	91	15.1	
Work Shift	Evening	188	31.2	
	Morning	415	68.8	
Item	Minimum	Maximum	Mean	Std. Deviation
Years of practice	0.5	39.0	6.42	7.74
Months in the ward	1.0	360.0	31.10	56.13

Table 2
Nurse Roles in preventing, identifying and reporting ADEs.

Factors	Subcategory	Frequency (N)	Percent (%)
Frequency of BP checking	QID	73	12.1
	TID	100	16.6
	BID	210	34.8
	QD	91	15.1
	N/A	129	21.4
Required to report ADEs	Yes	504	83.6
	No	98	16.3
Identified serious ADEs last month	Yes	278	46.1
	No	325	53.9
What to do when identify ADEs?	Yes	549	91.0
(choose all that apply)	No	54	9.0
1. Inform physician			
2. Inform pharmacist	Yes	122	20.2
	No	481	79.8
3. Treated by nurse	Yes	137	22.7
	No	466	77.3
Special medication error record	Yes	421	69.8
	No	182	30.2
Frequency of administration	Daily	8	1.3
Discrepancies	Twice weekly	5	0.8
	Weekly	19	3.2
	Twice monthly	4	0.7
	Monthly	31	5.1
	Rarely	536	88.9
Detect ADEs last week	Yes	266	44.1
	No	337	55.9
Fearful of ADE reporting	Yes	158	26.2
	No	444	73.6

the SEIPS model allowed to measure the principal organization domains influencing ADEs among inpatients: The personal characteristics of healthcare practitioner, organization factors, work environment, task, and tools.

Professional training of nurses can play an essential role to monitor and minimize ADEs. One of the positive findings was that most nurses can (83.6%) report the ADEs. This is comparable to a previous study finding which found that nurses had an effective role in reporting ADEs (Sri Ranganathan et al., 2003). Regular measuring of inpatient vital signs including BP can help to monitor the effectiveness of antihypertensive medicines and prevent ADEs such as hypotension and fall. The routine measuring of BP in the hospitals was done by nurses twice a day (34.8%). It is important to measure BP for most patients, particularly those with hypertension (Elis, 2015). Measuring BP for non-hypertensive patients who are admitted to hospitals is also important because BP level may increase due to hospital admission stress (Cappelleri et al., 2017). Nurses and nurse assistants may need training and workshops to overcome the work barriers (Dilles et al., 2011; Reason, 2000; Reason et al., 2001).

According to the study regression analysis, experience period (personal characteristic) of the nurses was significantly related to the incidence of ADEs in the hospitals. There was a negative relationship between the nurse experience and the incidence of ADEs whereas the experience increases, the incidence of ADEs decreases. Training sessions can enhance nurse experience in identifying ADEs which can help to increase ADE detection.

The workload of nurse tasks can impact the time available for ADEs prevention and detection. About half of nurses (58.2%) did not have enough time to detect ADEs. The main duties of nurses within hospitals are preparing and administering medications, inserting IV cannulas, and monitoring vital signs. Additionally, the survey showed that more than three-quarters of the nurses had to work fast. Thus, they may not have enough time to monitor ADEs adequately. Although the majority of nurses can measure vital signs like blood pressure, temperature and heart rate, most have not received enough training to detect the ADEs probably because their main duty is limited to administering medications. Because of inadequate nurse to patient ratio, more than half of the participants (63.2%) agreed that nurses have too much work to do. Nurses are multitasking practitioners who may impose work pressure on them. In a mixed study, nurses experienced barriers were highly relevant to medication management (7 to 10) including being interrupted during medication preparation and lack of

Table 3
Nurse responses to the SEIPS model items.

Factors	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)	Mean
Have enough time to detect ADE	62 (10.3)	289 (47.9)	181 (30.0)	37 (6.1)	34 (5.6)	3.51 (0.96)
Can check vital signs accurately	142(23.5)	276(45.8)	112(18.6)	50(8.3)	23(8.3)	3.77 (1.02)
Received training about ADEs	65(10.8)	229(38.0)	163(27.0)	97(16.10)	49(8.10)	3.27 (1.11)
Need to work fast	192(31.8)	281(46.6)	87(14.4)	28(4.6)	15(2.5)	4.01 (0.93)
Experience in ADE detection	67(11.1)	193(32.0)	196(32.5)	104(17.2)	43(7.1)	3.23 (1.08)
Doctor responds to nurse questions	105(17.4)	331(54.9)	123(20.4)	22(3.6)	22(3.6)	3.79 (0.90)
Pharmacist respond to nurse questions	120(19.9)	323(53.6)	114(18.9)	33(5.5)	13(2.2)	3.84 (0.88)
Strong collaboration with physicians	106(17.6)	271(44.9)	163(27.0)	33(5.5)	29(4.8)	3.65 (0.99)
Good location of nurse station	97(16.1)	291(48.3)	129(21.4)	42(7.0)	44(7.3)	3.59 (1.07)
Ward distracting noise	113(18.7)	140(23.2)	139(23.1)	136(22.6)	75(12.4)	3.13 (1.30)
Lots of Work	172 (28.5)	209 (34.7)	152 (25.2)	50 (8.3)	20 (3.3)	3.77 (1.06)
Interruption during drug administrating	125 (20.7)	201 (33.3)	125 (20.7)	94 (15.6)	58 (9.6)	3.40 (1.24)
Enough Glucose Meters	46 (7.6)	164 (27.2)	151 (25.0)	133 (22.1)	109 (18.1)	2.84 (1.22)
Ask patients about their medications	77 (12.8)	178 (46.1)	161 (26.7)	61 (10.1)	26 (4.3)	3.53 (0.98)
Preventing _ADEs is hospital priority	119 (19.7)	277 (45.9)	138 (22.9)	47 (7.8)	22 (3.6)	3.70 (0.99)
Enough BP meters	62 (10.3)	196 (32.5)	139 (23.1)	131(21.7)	75 (12.4)	3.07 (1.20)
Adequate number of nurses	65 (10.8)	156 (25.9)	136 (22.6)	109 (18.1)	137 (22.7)	2.84 (1.33)

Table 4
Binary logistic regression analysis of factors influencing the ADEs in hospitals.

Independent variable	Exp(B) (Odds Ratio)	95% C.I.for EXP(B)	P-value	
	Lower	Upper		
Adequate nurse time to detect ADEs	1.17	0.97	1.41	0.104
Adequate nurse experience to detect ADEs	0.83	0.71	0.97	**0.022***
Nurse-physician strong collaboration	0.84	0.70	1.00	**0.046***
Distracting noise	1.09	0.96	1.24	0.202
Adequate number of BP meters	0.88	0.76	1.01	0.071
Gender	0.78	0.54	1.13	0.188
Experience in the Ward (months)	1.00	0.99	1.00	0.110
Shift (day/night)	1.31	0.53	1.10	0.144
Availability of reporting system	0.78	0.54	1.13	0.189

Non-significant (P-value = 0.742) Hosmer and Lemeshow Test mean the selected model has goodness of fit (good prediction)
* Significant association (P-value < 0.05) with the outcome variable (Incidence of ADEs per week, Yes vs No). First, we included all 17 SEIPS variables then used backward selection to exclude most non-significant variables. Finally, we selected one variable from each domain.

Table 5
Relationship between the incidence of ADEs and avoid reporting behavior.

		ADEs in the last week, N (%)	P-value
Fear from ADE reporting	No	185 (69.5)	0.027*
	Yes	81 (30.5)	
	Total	266 (100)	

0 cells (0.0%) have expected count<5.
The minimum expected count is 70.14.
* Significant difference (P-value < 0.05) according to Chi-square.

Table 6
The measurement of survey item reliability (internal consistency).

Domain/scale	Number of items	Cronbach's Alpha
Tool	2	0.62
Environment	2	0.58
Organization	3	0.72
Task	2	0.60
Person	2	0.63

time to review medication before administration (Dilles et al., 2011). Hence, keeping adequate number of nurses is critical to minimize ADEs among inpatients.

Organization factors including interprofessional collaboration had been reported as significant factors to minimize ADEs (Al-Jumaili and Doucette, 2018). More than a half of the participating nurses stated that the doctors and pharmacist respond to their questions. Recent Iraqi studies showed hospital pharmacist can minimize ADEs and enhance clinical outcome of patients (Abbood et al., 2019; Jabri et al., 2020) Thus, nurse-pharmacist collaboration is essential to promote patient medication safety. Additionally, there was good collaboration between the nurses and doctors which is vital to detect ADEs. The survey also showed that when most nurses (91.0%) detect ADEs in the participating hospitals, they inform doctors. A previous study dealing with multiple barriers to safe medication practices found that one of the most common risk factors of medication errors was inadequate staff communication (Vogelsmeier et al., 2007).

The logistic regression showed negative association between organization (interdisciplinary collaboration) and the incidence of ADEs in the hospitals. In other words, increasing collaboration between the physician and nurses would reduce the incidence of ADEs. Similarly, a previous study found that when the interdisciplinary collaboration is stronger, the ADEs will diminish (Topinková et al., 2012). In contrast, an Iraqi hospital study found that poor physician-pharmacist collaboration is associated with incidence of prescribed medication errors of 6.57 % (AL-Jumaili et al., 2016).

The nurses' responses also showed that there was good communication between nurses and patients. Most nurses ask patients whether they have any questions about medications. However, some nurses did not ask patients about their medication concerns. That poor communication was probably because the nurses did not have enough background information about medications, or there was not enough number of nurses.

In addition to personal practitioner characteristics, tasks and interprofessional collaboration, work environment can determine the incidence of ADEs among institutional patients. Quiet environment can help nurses achieve their job completely and precisely.

However, in this study, we noticed that most public hospitals experience noise and crowdedness, which could negatively impact nurse accuracy of giving medications. Iraqi public hospitals are heavily subsidized and serve large number of people which make them always crowded. For example, they served more than three million inpatients in 2019 according to the Ministry of Health report (AL-Jumaili, 2020). In an American survey of 284 hospital nurses, nurse interruption was perceived to be the major reason for medication errors among pediatrics (Stratton et al., 2004). Similarly, in a London teaching hospital, 94 % of participating nurses highlighted distractions as a major contributor to medication errors (Fry and Dacey, 2007).

Although the work environments did not show significant relationship with the incidence of ADEs according to our regression analysis, the nurses reported high prevalence of interruption and distraction. Additionally, several studies highlighted the contribution of inadequate work environment to medication errors and ADEs. In a previous observational study using SEIPS model, intensive care unit (ICU) nurses experience a variety of performance obstacles in their work environment including noise, distractions, crowdedness and interruptions, in addition to spending long time teaching families and inadequate equipment and supplies (Gurses and Carayon, 2007). Ordered by frequency, they found the contributing factors of medication errors were human errors, transcription errors, distractions, and following faulty policies and procedures. Other risk factors induced medication mistakes were due to poor communication, confusion, inadequate information, and incorrect medication administration (Vogelsmeier et al., 2007). Providing adequate nurse/patient ratio may help to reduce interruption and allows nurses to be more focus on ADE preventing.

Tools and technologies can also be pivotal determinants that help to identify potential ADEs and help nurses to detect ADEs in early stages. The participating nurses stated there was a shortage in glucose and BP meters in the hospitals, which is common in Iraqi public hospitals. A previous observational study identified five broad types of performance obstacles facing hospital nurses including missing or incorrect information, missing or broken equipment, waiting for a resource, inadequate supplies, and large workload on nurses (Tucker and Edmondson, 2003). Tucker and Edmondson (2003) reported large nurses' workload which causes multiple performance flaws. This study also identified several performance obstacles related to physical work environment (insufficient space for nurses to complete their paperwork, noisy and crowded work environment) and inadequate intra-hospital patient transport (Tucker and Edmondson, 2003). Adoption of electronic health record and providing adequate number of vital sign (BP/glucose) meters can help to minimize and identify ADEs at early stages.

Regarding to the outcome reporting, about one-quarter of nurses indicated they avoid reporting ADEs to avoid punishment. Similarly, most nurses reported "rare" medication administration discrepancies. This under-reporting may be due to the blame culture in Iraqi healthcare system. As shown in the Chi-square results, nurses who were not afraid from the punishment tend to report ADEs more frequently. However, some nurses reported medication administration discrepancies, which may be due to an inadequate number of nurses facing too much work. This nurse workload can increase medication errors and negatively impact patient health.

This study was limited to 11 hospitals in two provinces, but they are typical public hospitals. Additionally, the sampling was convenience, and the sample size was relatively small.

5. Conclusions

This study identified several challenges influencing nurse performance and subsequently impact patient medication safety. These challenges include shortage in nurses, inadequate nurse experience in ADE detection, no training to detect ADEs was received, fear of reporting ADEs, and lack in monitoring equipment. The SEIPS model identified two organization factors significantly influencing ADE incidence including nurse-physician collaboration and nurse experience in ADE detection. Increasing nurse/patient ration can offer nurses more time to monitor and minimize ADEs. Providing more monitoring equipment such as BP and glucose meters can minimize ADEs. Finally, providing training courses in how to identify ADEs can enhance ADE detection.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. The SEIPS model items with main domains

Item	Domain	Variable
1. All nurses can take patient vital signs (BP, pulse rate, respiratory rate and temp) accurately.	Person	skills
2. All nurses of this hospital have adequate training to recognize adverse drug events' (ADEs) signs and symptoms.	Person	training
3. All the nurses at this hospital have adequate experience to recognize adverse drug event signs and symptoms.	Person	Experience
4. The hospital nurses have adequate time to notice medication-related problems.	Task	Workload
5. At this facility, nurses' job requires working fast.	Task	workload
6. The facility nurses are asked to do too much work	Task	Workload
7. Our ward has adequate number of nurses compared to the required work.	Organization	Nurse/patient ratio
8. The physicians are readily accessible to answer nurse questions about medication order	Organization	Nurse-physician collaboration
9. The clinical pharmacist is readily accessible to answer nurse questions about medication administration	Organization	Nurse-pharmacist collaboration
10. There is a strong collaboration between the hospital nurses and all physicians	Organization	Nurse-physician collaboration
11. The nurses' station is located in a convenient place to optimize medication administration.	Environment	location
12. The medical ward has a distracting noise	Environment	Distraction
13. The facility nurses are interrupted during IV medication and fluids preparation and administration	Environment	Interruption

(continued on next page)

The SEIPS model items with main domains (*continued*)

Item	Domain	Variable
14. Our facility has an adequate number of glucose meters to meet our testing needs.	Tools/ technology	glucose meters
15. Our ward has an adequate number of BP meters to meet our testing needs.	Tools/ technology	Technology
16. The hospital nurses usually ask patients about any concerns they have about their medications.	Process	
17. Preventing ADEs is a priority for this hospital.	Process	

All the table items have the same coding: Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree = 4, Strongly Agree = 5.

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