

ORIGINAL PAPER

VISITORS AND EQUIPMENT FAILURE AS PREDICTORS OF INTERRUPTIONS AMONG NURSES

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Abstract

Aim: To discover the perceived level of nursing interruptions during care activities. The study evaluates the contributing factors of alarms, equipment failures, visitors, and telephone calls in predicting interruptions according to the site of nurses' work. It also examines the potential association of demographic factors of nurses with interruption levels. **Design:** A cross-sectional study. **Methods:** The study included nurses working at a tertiary hospital in Amman, the capital of Jordan. Data collections were carried out between May and July 2020. The analysis was performed using 257 valid questionnaires, comprising 128 male and 129 female respondents. The study used a nursing interruptions scale and an interruptions scale related to patients and hospitals. **Results:** Results indicated that the participating nurses generally experienced a high level of interruptions during nursing care activities. Visitors were found to be the main predictor of nursing interruptions on the surgical / medical floor; whereas equipment failure was found to be the main predictor of nursing interruptions in intensive care units. Finally, the demographic factors of marital status and educational level were associated with interruptions. **Conclusion:** Visitors and equipment failures are the main predictors of interruptions during nursing care activities. Our results provide a clear explanation for organizations, nurse managers, and clinicians of the factors behind nursing interruptions.

Keywords: equipment failure, interruption, nurses, visitors.

Introduction

Work interruptions can occur in any profession, while interruptions in a caring profession such as nursing have a direct effect on patient safety via errors in clinical practice, failures in many procedures, and negative impact on nurses' cognition (McGillis et al., 2010). Nurses who provide direct care to patients suffer from many interruptions due to their multiple tasks and excessive workloads (Alfuqaha & Alsharah, 2018; Sasangohar et al., 2014). However, interruptions can also be beneficial for nurses if they support safe decision making, improve patient comfort, and increase accuracy (Sasangohar et al., 2012). Thus, nursing interruptions deserve to be the object of more research, policies, and management plans to enhance proper nursing care, increase task efficacy, and improve productivity (Schroers, 2018).

Interruptions among nurses have received considerable attention in hospitals due to their harmful potentialities for patient safety and missed

nursing care activities (Cole et al., 2016; McGillis et al., 2010). Nursing care activities are mainly associated with medication administration, checking vital signs, cardiac monitoring, and interacting physically and emotionally with acute and chronic patients (Cho et al., 2020; Huber et al., 2021). Interruptions can be defined as any external or internal factors that disrupt or suspend nursing care activities (Bonafide et al., 2020). These interruptions might be related to visitors, co-workers, interpersonal communication, and technology (Prates & Silva, 2016). In a similar vein, previous studies have indicated that telephone calls, documentation, patients' families, medical equipment failure, and alarms may be considered interruption factors for nurses (Rivera-Rodriguez & Karsh, 2010).

Interruptions related to patients' families contribute significantly more to time interruptions than those related to staff interruptions (Cole et al., 2016). Alarm processes frequently interrupt nursing care procedures, leading to loss of critical information about patients and resulting in adverse patient events (Spooner et al., 2015). Interruptions can also be related to hospitals, such as medical equipment failures and telephone / cellphone calls, although

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smartphones help nurses fulfill tasks according to guidelines and policies without abuse (Gill et al., 2012). Nevertheless, many studies have reported that use of phones / smartphones by nurses may contribute to interruptions of primary tasks, and discontinuation of clinical tasks with negative consequences to patient safety (McBride, 2015; Pucciarelli et al., 2019). Equipment failure is also reported as an interruption among healthcare providers – especially in operating rooms, where it is negatively associated with the functioning of the health team (Antoniadis et al., 2014).

Patient safety is an important goal in hospitals; nurses, as a part of such settings, play the main role in maintaining the safety of the patients. Interruptions can cause many negative consequences for nurses and patients, i.e., physical and emotional exhaustion in nurses (Alfuqaha & Alsharah, 2018), medication errors, and other threats to patient safety (Xie et al., 2020). Hospitals in Jordan generally follow international policies and guidelines regarding visiting hours. Visiting hours vary according to patient location (i.e., ICUs, medical / surgical / pediatric floors). Visitors to floor patients can visit between 4pm–7pm, with a maximum of two visitors. ICU visits are more restricted and limited. There are many issues that undermine visiting hours rules such as tradition and cultural background among Jordanians. They tend to visit patients outside the permitted period, and the number of visitors is unrestricted, which makes it more difficult for hospitals, and nurses in particular, to deliver adequate care.

To provide proper nursing care to patients, it is important to discover the main predictors leading to increased nursing interruptions and to, thereby, decrease the level of nursing errors. However, nursing interruption factors related to patients (visitors and alarms) and to hospitals (equipment failures and telephone calls) have not been well understood in previous studies.

Aim

The primary aim of this study was to discover the perceived level of nursing interruptions during care activities in terms of patient interruptions (visitors and alarms), and hospital interruptions (equipment failures and telephone calls); second, to evaluate the contributing factors of visitors, alarms, equipment failures, and telephone calls in predicting nursing interruptions according to nurses' site of work; and, third, to examine the potential association of certain demographic

factors of nurses (such as gender, marital status, and educational level) with interruption levels.

Methods

Design

A cross-sectional study.

Sample

We conveniently selected a tertiary hospital in Amman, the capital of Jordan, since it provides a wide variety of medical services. Out of approximately 850 nurses in the selected hospital, a sample size of at least 274 nurses would be necessary to have a confidence level of 95% and a margin of error 5% (Hajian-Tilaki, 2011). Managers, supervisors, nurses in outpatient clinics, and nurses who were employed for only a few days were excluded from this study due to the nature of their work and their lack of experience in the selected hospital. Inclusion criteria were all staff nurses with different educational levels, different experience, and different work sites. The selected hospital has several medical / surgical floors and intensive care units (ICUs), such as pediatric ICU, surgical ICU, neuro ICU, cardiac ICU, and neonatal ICU. However, to achieve the required sample size, we distributed a total of 300 self-report questionnaires to different work sites in the selected hospital: i.e., medical floors, surgical floors, ICUs, and others such as royal and maternity floors. We distributed self-report questionnaires to participants at the start of day. The questionnaires included a consent form, demographic factors (including gender, marital status, site of work, and educational level), a nursing interruptions scale, and interruptions scales related to patients and hospital. The questionnaires were collected as soon as participants had completed them. On average, participants took about five minutes to complete the survey.

Data collection

The study was conducted between May and July 2020. A total of 279 nurses returned the survey, a response rate of 93%. We received 22 incomplete questionnaires, which led to a final total of 257 nurses participating in the study. The self-administered survey was measured on a four-point Likert-type scale (1 for “Strongly disagree”, 2 for “Disagree”, 3 for “Agree”, and 4 for “Strongly agree”). A high average score on the scale represented a high level of interruptions. The cutoff point was 2.5. The original English version of the scale was used since nurses in Jordan study English. The consent form, demographic factors,

nursing interruptions scale, and the interruptions scales related to patients and hospitals were used in data collection as follows:

Consent form: Participants were asked to provide written informed consent to participation in the study.

Demographic factors: Participants were asked questions on demographic characteristics including gender, marital status, site of work, and educational level.

Nursing interruption scale: The nursing interruptions scale was used to discover the perceived level of nursing interruptions during all nursing care activities, which mainly involve medication administration, checking vital signs, cardiac monitoring, and physical interaction with patients. The scale comprises ten items and was adapted from the previous literature of Sasaki & Perroca (2017); and Xie et al. (2020). To test the psychometric properties of the nursing interruptions scale, the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity [calculating chi-square value (χ^2)] were performed; the result of the KMO test was 0.88 and Bartlett's test of sphericity was $\chi^2 = 839.31$; $p < 0.001$ (Howard, 2016). Correlation coefficients between items ranged between 0.62–0.84. The Cronbach's alpha of the nursing interruptions scale was 0.87.

Patient interruptions scale: The patient interruptions scale was used to measure the two dimensions of interruptions related to patients: i.e., alarms and visitors. Thirteen items were obtained from the two dimensions. Alarms are mainly intended to alert nurses to patient problems. However, alarm items in this study related to false alarms, alarm volume, and unnecessary alarms that lead to nursing interruptions. This dimension consists of six items, according to Roth et al. (2015). Visitor items are used by Roth et al. (2015) to measure interruptions among nurses during nursing care activities. This dimension consisted of seven items. Regarding the patient interruptions scale, the KMO test result was 0.81 and Bartlett's test of sphericity was $\chi^2 = 990.38$; $p < 0.001$ (Howard, 2016). Correlation coefficients ranged between 0.59–0.91 for the alarms item, and

0.61–0.86 for the visitors item. Cronbach's alpha for the alarms item was 0.76 and 0.83 for the visitors item. The total Cronbach's alpha score for the patients' interruptions scale was 0.80.

Hospital interruptions scale: The hospital interruptions scale was used to evaluate the two dimensions of interruptions related to the hospital: i.e., equipment failure and telephone calls. Fifteen items were obtained from the two dimensions. Equipment failure items evaluate the failures of medical equipment in the hospital: i.e., digital blood pressure, electronic thermometer, pulse oximeter, etc., and consist of seven items, according to Xie et al. (2020); Zide et al. (2017). Telephone call items measure the level of telephone calls that disturb care activities as perceived by nurses (every department or ICU in hospitals contains a landline or cellphone). The scale consists of eight items, according to Zide et al. (2017). Regarding the validity and reliability of the hospital interruptions scale, the KMO test result was 0.80 and Bartlett's test of sphericity was $\chi^2 = 936.53$; $p < 0.001$. Correlation coefficients between items of equipment failure ranged between 0.51–0.81 and 0.60–0.84 for the items of telephone calls. The Cronbach's alpha was 0.85 and 0.79 for equipment failures and telephone calls, respectively. The total Cronbach's alpha score for the hospital interruptions scale was 0.81.

To assess multicollinearity between independent variables (alarms, equipment failures, visitors, and telephone calls) and the dependent variable (nursing interruptions), correlation coefficients and variance inflation factor (VIF) were performed, and the results are displayed in Table 1.

The correlation coefficients between independent variables and the dependent variable were found to be between 0.26 and 0.54, indicating moderate correlation coefficients (Table 1). VIF ranged between 1.42–1.60. As a result, there were no multicollinearity issues between the dependent variable and all the predictors in this study (Lavery et al., 2019).

Table 1 Correlation coefficients and variance inflation factors between independent variables and the dependent variable (n = 257)

#	Factor	1	2	3	4	5	VIF ^a
1	Nursing interruption scale (Dependent)	----					----
2	Alarms scale	0.26**	----				1.60
3	Visitors scale	0.45**	0.40**	----			1.42
4	Equipment failure scale	0.41**	0.47**	0.46**	----		1.50
5	Telephone calls scale	0.38**	0.54**	0.44**	0.44**	----	1.59

VIF – variance inflation factors; a – dependent variable, Nursing Interruption Scale; ** $p \leq 0.01$.

Data analysis

We employed the Statistical Package for Social Sciences (SPSS v.22) to analyze the results. Descriptive statistics, t-test, one-way analysis of variance (ANOVA), and linear regression analysis by stepwise method were calculated to achieve the study objectives. Finally, the p-value was set at 0.05.

Results

A total of 257 participants, comprising 128 males and 129 females, were normally distributed. Nurses' demographic factors are summarized in Table 2.

The majority of nurses in the tertiary hospital in Jordan were married, worked on the medical or surgical floor, and held a bachelor's degree. The gender split of the participants was relatively even (Table 2).

To achieve aim number one, descriptive statistics and overall levels were determined (see Table 3). The mean score of nursing interruptions was 3.59 (± 0.35), which indicated a high level of interruptions among participating nurses. The total score of interruptions related to the patient was higher than interruptions related to the hospital, and a paired sample t-test showed that there were statistically significant differences between interruptions related to the patient and interruptions related to hospital ($\text{mean}_{\text{patients}} = 3.41$; $\text{mean}_{\text{hospitals}} = 3.29$; $t = 6.61$; $df = 256$; $p < 0.001$). Visitors exhibited the highest mean score among the four dimensions related to patient and hospital interruptions. Nurses in the current study were found to experience a high level of interruptions regarding alarms, equipment failures, and telephone calls among nurses (Table 3).

Table 2 Demographic factors of the study participants (n = 257)

Variables	Descriptive	n	%
Gender	male	128	49.8
	female	129	50.2
Marital status	single	86	33.5
	married	171	66.5
Site of work	medical / surgical floors	156	60.7
	ICUs	80	31.1
	others	21	8.2
Educational level	diploma	39	15.2
	bachelor	184	71.6
	post-graduate	34	13.2

ICUs – intensive care units; others – royal and maternity floors

Table 3 Means, standard deviations, and overall levels for all selected variables among nurses (n = 257)

Variables	Dimension	Overall levels	mean	SD
Nursing interruption	nursing interruption	high	3.59	0.35
Patient interruptions	alarms	high	3.21	0.44
	visitors	high	3.57	0.35
	total score	high	3.41	0.33
	equipment failure	high	3.34	0.39
Hospital interruptions	telephone calls	high	3.27	0.38
	total score	high	3.29	0.32

SD – standard deviation

To accomplish the second aim, linear regression analysis by stepwise method was applied (see Table 4). Three factors significantly predicted nursing interruptions: visitors, equipment failures, and telephone calls, with a total variation of 27.8%. The results indicated that the visitors factor was the main predictor of nursing interruptions, accounting for 20% ($R^2 = 0.20$; $p < 0.001$). Equipment failure and alarm were also considered predictors of nursing interruptions with total variation of 5.2% and 1.8% respectively (Table 4). We ran a regression analysis based on the site of nurses'

work (i.e., ICUs vs surgical / medical floor) separately to establish whether there were any differences between them in terms of the predictors of interruptions. Visitors and equipment failure remained the major predictors of nursing interruptions, with different variations according to the site of work. Visitors was found to be the main predictor of nursing interruptions on the surgical / medical floor ($n = 156$) with a contribution to variance of 21.5%, but this was not the case with ICU nurses ($n = 80$). The contribution to variance of equipment failure was found to be

higher in ICU nurses (18.3%) compared to that in surgical / medical floor nurses (4.1%). Furthermore, telephone calls was found to be an additional predictor of interruptions in nurses overall ($n = 257$), with a variance of 1.8%.

The potential association of certain demographic factors of nurses, such as gender, marital status, and educational level (the examination of which constitutes the final aim of the study) is illustrated below. The independent sample t-test indicated that gender had no statistically significant effect on nursing interruption levels (male = 3.61; female = 3.58; $t = 0.68$; $p = 0.50$). Results revealed that there was a statistically significant difference based on marital status: single nurses suffered from interruptions more than married nurses (single = 3.65;

married = 3.56; $t = 1.97$; $p = 0.05$). Finally, there was a statistically significant difference in nursing interruptions related to educational level according to the ANOVA test ($F = 3.12$; $p = 0.04$). Since significant difference was found between educational levels, a post-hoc Scheffe multiple comparison test was used to ascertain which group had the highest level of nursing interruptions. A significant difference was found between educational level group 1 (diploma nurses) and group 2 (post-graduate nurses). Diploma nurses were found to have the highest level of interruptions (Table 5). Regarding other educational levels (bachelor and post-graduate) no differences were found in terms of level of interruptions.

Table 4 Results of multiple linear regression analysis (stepwise regression) for interruptions predictors among nurses ($n = 257$)

Model	R	R ²	R change	Unstandardized Coefficient B	Std. Error	t	Sig.
1 ^a	0.451 ^a	0.203	0.200	1.974	0.201	9.798	< 0.001**
2 ^b	0.508 ^b	0.258	0.252	0.452	0.056	8.064	< 0.001**
				1.613	0.212	7.608	< 0.001**
				0.329	0.061	5.369	< 0.001**
				0.240	0.056	0.264	< 0.001**
3 ^c	0.528 ^c	0.278	0.270	1.434	0.220	6.522	< 0.001**
				0.278	0.063	4.381	< 0.001**
				0.194	0.058	0.213	< 0.001**
				0.158	0.059	0.168	0.008**

^aPredictors – (constant), visitors; ^bPredictors – (constant), visitors, equipment failure; ^cPredictors – (constant), visitors, equipment failure, telephone calls;

** $p \leq 0.01$; t – t-test; B – unstandardized beta; Std. error – standard error; R² – R-squared; Sig. – significance

Table 5 Effect of educational level on the interruption levels among nurses ($n = 257$)

(I) Educational level	n mean (SD)	(J) Educational level	mean Difference (I–J)	Std. error	Sig.	95% CI Lower bound Upper bound
Diploma	39 3.68 (0.32)	bachelor	0.093	0.061	0.318	-0.058 0.245
		post-graduate	0.205*	0.082	0.046	0.003 0.407
Bachelor	184 3.59 (0.35)	diploma	-0.093	0.061	0.318	-0.245 0.058
		post-graduate	0.111	0.065	0.234	-0.049 0.272
Post-graduate	34 3.48 (0.37)	diploma	-0.205*	0.082	0.046	-0.407 -0.003
		bachelor	-0.111	0.065	0.234	-0.272 0.049

$p \leq 0.05$ *; SD – standard deviation; Std. error – standard error; Sig. – significance; CI – confidence interval

Discussion

We found that nurses in the current study suffered from a high level of interruptions. This result agrees with previous studies by Forsyth et al. (2018); Prates & Silva (2016); Sassaki & Perroca (2017); and Xie et al. (2020). Our results indicated that the total score of patient interruptions (visitors and alarms) is higher than the total score of hospital interruptions (equipment failures and telephone calls); and this difference is statistically significant. A possible explanation may relate to high pressure from visitors

leading to physical and emotional exhaustion, or may relate to Jordanian cultural factors that may inhibit nurses in controlling visitors. This finding agrees with the previous studies by Alfquaha et al. (2019); Cole et al. (2016); MacPhee et al. (2017); and Xie et al. (2020). The accumulation of stressors on nurses leads to adverse consequences (Alfquaha et al., 2021).

Visitors exhibited the highest mean score and served as a significant predictor of interruptions. Visitors appeared to increase the risk of errors during

medication administrations, checking vital signs, and monitoring ill patients. Visitors was found to be the main predictor of nurse interruptions on surgical / medical floors but not in ICUs. This can be explained by the fact that visitors to surgical / medical floors visit patients both during visiting hours and outside of them, the number of visitors to the floors is unrestricted, and they directly interfere with nursing care activities. In contrast, visitors to ICUs face restricted hours, closed doors, and a maximum of one visitor at a time. On the other hand, equipment failure is found to be the main predictor of nursing interruptions in ICUs. Potential explanations for higher interruptions due to equipment failure among ICU nurses include recurrent mechanical problems, greater failure of medical equipment and materials, and longer time to get new equipment. These results are consistent with previous studies (Andersson et al., 2019; Ribeiro et al., 2018). Another study in Australia showed that nurses are interrupted due to personal issues and work-specific matters (Spooner et al., 2019). Therefore, more study is needed to illustrate the role of these factors on patient safety.

Telephone calls were neither a predictor of interruptions in ICU nurses nor surgical / medical floor nurses. This result indicated that visitors and equipment failure were more problematic among nurses in this study compared to the predictor of telephone calls. Nevertheless, nurses suffered from excessive telephone calls from their leaders / managers and external phone calls that diverted nurses' attention away from their primary tasks (Rivera-Rodriguez & Karsh, 2010). Previous studies have reported that the most frequent interruptions among nurses occur during medication administrations (Duruk et al., 2016). Higher job demands and lower job resources are associated with early retirement among United States workers (Kubicek et al., 2010). Our results agree with previous studies by Xie et al. (2020) and Andersson et al. (2019), which suggest that leaders' attention, position, professional title, and unmet needs are predictors of nursing interruptions.

Statistical analysis indicated that marital status and educational level of nurses were associated with level of interruptions. Gender was not associated with level of interruptions. This result can be explained by male and female nurses experiencing the same types of interruptions. Our results tally with the study by MacPhee et al. (2017). Single nurses are more prone to interruptions than married nurses, suggesting that married nurses can deal better with interruptions due to their role as married partners and parents. However, this result contradicts the study by Pinquart

& Sørensen (2011), which found that married caregivers experienced a higher level of work interruptions. Finally, nurses of lower educational levels were more consistently interrupted than nurses with higher educational levels. This result can be explained by the fact that nurses with diplomas are responsible for answering the alarms of patients, as well as direct contact with the patients and their visitors, while nurses with higher educational levels can resolve interruptions more easily.

Limitation of study

There were certain limitations to the study. The use of a cross-sectional study design usually limits the extent to which results can be generalized. Another limitation is the sample of participants in this study, which was restricted only to bedside nurses.

Conclusion

The nature of the types of patient on medical / surgical floors would indicate there would be higher visitor issues here than in ICUs, and, conversely, that there would be higher equipment failures in ICUs than on the general floors as ICU nurses use more equipment. Single nurses and diploma nurses suffer more from interruptions than married nurses and those with other educational levels. Our results provide a clear explanation for organizations, nurse managers, and clinicians of the factors behind nursing interruptions. Hospitals should limit the number of visitors outside the permitted visiting period. At the same time, we realize that this is complicated by the patient-centered approach and cultural background of hospitals. It would, therefore, be beneficial to provide educational programs to nurses on how to deal with interruptions. Finally, managers should tackle the problem of equipment failure in hospitals. This could eventually lead to improvements in the quality and safety of care.

Ethical aspects and conflict of interest

The study was approved by the Institutional Review Board of the tertiary hospital in Amman-Jordan on June 10, 2020, according to reference number 9595. The declaration of Helsinki guidelines were followed at all times. Participants took part in the survey voluntarily after providing their written consent. The authors declare no conflict of interests.

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Author contributions

Conception and design (OAA, MHA), data collection (EJ) data analysis and interpretation (OAA, MHA, ASB, WTM), manuscript draft (ASB, WTM), critical revision of the manuscript (OAA, MHA), final approval of the manuscript (OAA).

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