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Designing an Alarm Fatigue Assessment Questionnaire: Evaluation of the Validity and Reliability of an Instrument

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Abstract

Background: In intensive care units (ICU), there should be some more facilities and equipment such as ventilators, monitors, suction pumps, etc. These devices are equipped with an alarm system in their settings. Sometimes, too many alarms cause alarm fatigue among nurses and consequently would jeopardize the safety of patients. Therefore, the current study aimed at designing a tool to assess the alarm fatigue among nurses.

Methods: In the current developmental, analytic study, using reliable databases, an alarm fatigue questionnaire was designed with 32 items. The content of the tool was measured by the panel of experts and its reliability was measured by Cronbach's alpha. Data were analyzed with SPSS software version 21.

Results: The results showed that 9 out of 32 items of the questionnaire had low content validity index and ratio (CVI/CVR) and should be rejected; the index value of the questionnaire was 0.7 that was acceptable. The results showed that the final questionnaire was reliable ($\alpha = 0.806$) with test-retest, which was repeatable.

Conclusions: Since the alarm fatigue can jeopardize the patients' safety, it is required to use a reliable tool for its assessment. According to the obtained results in the current study, the present questionnaire had a relatively appropriate validity.

Keywords: Fatigue Alarm, Intensive Care Unit, Questionnaire, Relibility, Validity

1. Background

The most critically ill patients are taken care of and treated by the most competent nurses and doctors under the best conditions with the newest and best-equipped vehicles in the intensive care units (ICUs). The aim to establish an ICU is to provide critically ill patients with specialized and super specialized services and intensive care for medical and surgery patients (1).

The main purpose of admitting patients to the ICU are securing and maintaining the normal function of the damaged organs and preventing damage to the healthy ones. To achieve these goals, help should be sought from knowledgeable, skilled, and experienced human force. Moreover, adequate and safe facilities and equipment such as ventilators, monitors, suction pumps, and useful drugs are needed (2).

A part of these equipments are alarm systems; but, despite the fact that the appearance of such changes is helpful in the health care community, it can have considerable harmful consequences for the users and health care providers if not applied properly; for example, if not appropriate for the treatment environment or not reviewed and used properly. As a result, they neglect the actual alarms of the equipment, and lack of appropriate and timely response results in some problems for the patients.

In general, controlling and monitoring in the ICU are performed precisely with the constancy of physiological alarms. In fact, physiological alarms are part of the means of constancy of physiologic state of human (1).

The purpose of the clinical alarms is to increase the patients' safety. Clinical alarms go off when the patient's condition is deteriorating or when the medical supplies are in trouble (3).

The researchers demonstrated that 72% - 99% of the alarms are false, and increase in such false alarms can cause fatigue (4). Alarm setting and management in the ICU are among the key responsibilities of the nurses. Sometimes a patient is daily faced with more than 400 alarms (5).

From 2005 to 2008, food and drug administration (FDA) reported 255 deaths due to the alarm of medical equipment monitors (6). Alarms are designed to alert nurses to an abnormal condition. Their excessive increase leads to alarm fatigue and thereby deactivating, quieting, and ignoring them (7).

Physiologic monitors generate fatigue in nurses with annoying alarms and visual warnings and this threatens the patients' lives (8). Fatigue failure means negligence in recognizing and responding to the right alarms requiring clinical interventions (5).

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Alarm fatigue is a kind of human error that makes the person indifferent to the alarms and warnings (9). McKay showed that tiredness of alarms and their proper management is a major concern nowadays, and it is necessary to train doctors and nurses how to safely manage alarms (10).

Marjorie Funk believed that bad results follow fatigue alarms and it should be tried to find some ways to reduce such risks (11). As patients' safety is a priority in hospitals, the joint commission suggested developing a system for alarm management as a new national goal and it is recommended designing policies and methods to minimize alarm fatigue among the clinical staff. In order to manage alarms, since January 2014, hospitals are required to recognize important and emergency signals. Also, the staff and the licensed practitioners should be trained about the purpose and the proper utilization of alarm systems (12, 13).

By 2016, all hospitals should develop and implement specific protocols in order to curb unnecessary alarms (14, 15). According to the conducted studies and significance of alarms embedded in the medical equipment as well as increase in the efficiency of the medical equipment besides increase in their quality and taking care of patients in the intensive care unit, assessing alarm fatigue among the nurses working in such units seems necessary.

The current study aimed at designing a tool to examine and assess alarm fatigue in nurses working in the ICUs, through getting more familiar with this human error and offering appropriate strategies to prevent and decrease it.

2. Methods

It was a developmental, analytical study. In the current study, after designing the questionnaire, content validity methods were used to examine its validity, the processes of which were as follows:

2.1. Designing the Questionnaire

1 - 1. Determining the content scope of the questionnaire: In the beginning, the content scope of the questionnaire was determined. Lavsheh (1975) recommended that the content scope of tools should be detected before determining its validity and reliability (16).

1 - 2. Specializing the items for the working environment and developing the initial questionnaire: In this phase, through holding meetings with 6 members in the working environment of the study (Moslemin hospital and nursing faculty of Baqiyatallah hospital), the collected items were divided into 2 categories; in a manner that the alarm fatigue was described and each member of the team was asked to note the items that seemingly result in fatigue alarm and after assembling the opinions of the members the items were divided into 2 groups:

I. Items that examine the nurses' insight about alarm fatigue.

II. Items that assess the alarm fatigue in nurses.

Given that this questionnaire was to assess alarm fatigue in nurses, the first group of items was removed. Therefore, the initial questionnaire with 32 items was designed.

1 - 3. Developing and adding efficiency to the questionnaire draft: Since the items were set forth by a special group, it seemed necessary to utilize the guidance of professors to develope the questionnaire. Hence, to assess its content validity ratio (CVR) and its content validity index (CVI), the initial questionnaire was designed in 4 sections (necessity, relevance, simplicity, and clarity) and it was given to a group of experts.

1 - 4. Selecting a pattern to assess content validity: The recommended Lavsheh method was used; the questionnaire was given to the panel group and they were asked to comment on each item in the determined judicative scale. The responses of the members were coded as follows: it was essential; it was useful, but not essential; and not necessary.

1 - 5. Identification of the panel members: Usually, the members of the panel group evaluating the validity should be the experts active in the domain of the questionnaire scope to enable accurate judgment. The initial questionnaire was given to 30 experts.

1 - 6. Distributing and collecting questionnaires of validity assessment: The members of the panel group were kept in contact, by telephone or e-mail. Finally, 25 completed questionnaires were handed to the researcher (Table 1).

Table 1. Composition and Specifications of Panel Group Members

Class	Number
Doctor of physiology	1
Internist	1
Anesthetist	4
Doctor of nursing	11
PHD student of nursing	4
Master of nursing	4
Total	25

Comments of the panel group were analyzed quantitively through measuting CVR: the commnets of the panel members, which was the necessary alternative, was quantified through the ratio of content validity (Lavsheh). The following formula was used for this purpose:

$$\frac{ne - \frac{n}{2}}{\frac{n}{2}} = CVR \quad (1)$$

Where ne is the number of panel members that recognized the item as “necessary”.

n/2: the total number of the group members divided by 2 (Table 2).

Table 2. The Minimum Amount of CVR for Different Numbers of Panel Members (Lavsheh)

Number of Panel Members	Minimum CVR, %
5	99
6	99
7	99
8	75
9	78
10	62
11	59
12	56
13	54
14	51
15	49
20	42
25	37
30	33
35	31
40	29

According to Lavsheh, in order to measure the average value of comments given for each component of the tool, a number was allocated.

“Necessary” was replaced with 2, “not necessary, but useful” with 1, and “unnecessary” with 0.

1 - 9- Determining the content validity index and introduction of the final questionnaire: The higher the final content validity was the more the amount of CVI inclined to 0.99.

$$CVI = \frac{\text{Number of raters giving a rating of "3" or "4"}}{\text{Total number of raters}} \quad (2)$$

The above formula was used in a way similar to that of Waltz and Basel (2005) protocol. Based on this formula, usually, 4 criteria of simplicity, clarity, specificity, and relevance in a 4-option Likert scale were used for each of the 4 dimensions. The obtained score for each item can be interpreted as follows:

The (CVI) score over 0.79% was suitable, between 70% - 79% needed to be revised, less than 70% was unacceptable (17) (Table 3).

In the process of completing the questionnaire, first the 32 items were designed and given to the panel group. The result of the panel group was assessed using the Lavsheh scale, as well as CVR and CVI equations in terms of validity and reliability by Cronbach’s alpha.

3. Results

After applying the equations 1 and 2, and examining the obtained results, finally, 9 items were removed and the final questionnaire with 23 items was developed (Table 4).

4. Discussion and Conclusion

Alarm fatigue is a kind of human error, which makes the person indifferent to the alarms and warnings. According to the medical association in 1999, human error is the leading cause of hospital death. Alarm fatigue can also cause delays in giving treatment, prescribing or giving the wrong medicine, and patients’ mortality (7).

According to the fact that in the studies conducted in the health care system of Iran, there is no published documentation related to fatigue alarms or a way to deal with it, and given that evidence-based care guidelines have considerably increased in the policy of the Ministry of Health; therefore, alarm fatigue should be proceededand evidence-based guidelines provided; and appropriate strategies should be taken into consideration and implemented with the help of the responsible authorities. For this purpose, designing the questionnaires to examine alarm fatigue among nurses in the ICUs seemed necessary. The current study aimed at designing a questionnaire with the help of scientific resources and the experiences of the ones employed in the ICUs by means of which the alarm fatigue can be assessed.

Finally, 9 items were removed and the final questionnaire was developed with 23 items. Nonetheless, for the internal consistency and reliability, it was suggested that the questionnaire be evaluated in other research settings too.

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Footnotes

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Table 3. CVR, CVI, and the Mean Scores of the Judgments and Acceptance/Rejection of the Items of the Questionnaire Examining the Alarm Fatigue

	Item	Relevance	Simplicity	Clarity	CVR	Mean Score	Acceptance/Rejection
1.	I pay attention to the changes of alarm source immediately after hearing the alarm.	1	0.87	0.79	1	2	Accepted
2.	I am sure that the alarms are true.	0.87	0.91	0.62	0.52	1.5	Accepted
3.	I go to the patients bed immediately after I hear the alarm.	1	1	1	0.84	1.8	Accepted
4.	I switch off the alarms at the beginning of my shift.	0.78	0.81	0.82	0.33	1.3	Rejected
5.	At the beginning of my shift, I set the alarms for an extent more than desirable.	0.90	0.86	0.95	0.25	1.2	Rejected
6.	During my shift, I limit the number of alarms.	0.79	0.79	0.75	0.58	1.8	Accepted
7.	Alarms hinder my focus on professional duties.	0.95	0.95	0.95	0.52	1.5	Accepted
8.	I get nervous when I hear alarms.	0.95	0.95	0.91	0.66	1.6	Accepted
9.	I have a proper professional reaction toward alarms.	1	0.91	0.91	0.75	1.7	Accepted
10.	I try to distinguish the informing alarms (yellow) and warning alarms (red).	0.87	0.87	0.75	0.50	1.5	Accepted
11.	I do not hurry with hearing the alarm; as it may be an auditory error.	0.76	0.85	0.80	0.27	1.2	Rejected
12.	I stop as I hear the alarm, maybe it is settled by itself.	0.91	0.91	0.86	0.41	1.4	Accepted
13.	I take action only for the continuous red alarms.	0.87	0.91	0.87	0.33	1.3	Rejected
14.	Sometimes I really do not hear the alarm.	0.70	0.79	0.87	0.33	1.3	Rejected
15.	I pay more attention to the alarms in night shifts.	0.91	0.91	0.95	0.83	1.8	Accepted
16.	My attention to the alarms is more in night shifts.	0.81	0.95	0.95	0.33	1.2	Accepted
17.	In the morning shift, the crowd hinder my immediate reaction to the alarm.	0.95	0.95	0.95	0.52	1.5	Accepted
18.	At the beginning of each shift, I pay more attention to the alarms.	0.95	0.95	0.95	0.92	1.9	Accepted
19.	I have an immediate reaction to the ventilator alarms.	0.95	0.95	0.95	0.60	1.6	Accepted
20.	I have an immediate reaction to the infusion pump alarms.	0.95	0.86	0.95	0.58	1.8	Accepted
21.	I have an immediate reaction to cardiac monitoring. alarms	0.95	0.95	0.91	0.76	1.7	Accepted
22.	In the course of time, my sensitivity to alarms decreases.	0.91	0.86	0.86	0.66	1.6	Accepted
23.	I am indifferent to alarms.	0.87	0.95	0.91	0.52	1.5	Accepted
24.	Duringa CPR in a patient, I become indifferent to the alarms of other patients.	0.83	0.91	0.95	0.66	1.6	Accepted
25.	The sound of some alarms are annoying, I turn them off.	0.95	0.91	0.95	0.36	1.3	Rejected
26.	By repetition of alarms, I become indifferent to them.	0.91	0.91	0.91	0.82	1.8	Accepted
27.	I make a distinction between yellow and red ventilator alarms.	0.80	0.71	0.85	0.33	1.3	Rejected
28.	The sounds of alarms are annoying to me.	0.84	0.84	0.84	0.26	1.2	Rejected
29.	Multiplicity and concurrence of alarms confuse me in making decisions.	0.87	0.95	0.87	0.66	1.6	Accepted
30.	I do not pay attention to the alarm when I do not feel well.	1	1	0.95	0.82	1.8	Accepted
31.	I inactivate the alarms in the night shifts.	0.86	0.95	0.95	0.56	1.5	Accepted
32.	I become confused with successive sounds of alarms.	1	1	1	0.57	1.5	Accepted

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Table 4. Items

	Item	Always	Usually	Sometimes	Rarely	Never
1	I pay attention to the changes of alarm source immediately after hearing the alarm.					
2	I am sure that the alarms are true.					
3	I go to the patients bed immediately after I hear alarms.					
4	During my shift, I limit the number of alarms.					
5	Alarms hinder my focus on professional duties.					
6	I get nervous when I hear an alarm.					
7	I have a proper professional reaction toward alarms.					
8	I try to distinguish the informing alarms (yellow) and warning alarms (red).					
9	I stop as I hear the alarm, maybe it is settled by itself.					
10	I pay more attention to the alarms in night shifts.					
11	In the morning shift, the crowd hinder my immediate reaction to alarms.					
12	At the beginning of each shift, I pay more attention to the alarms.					
13	I have an immediate reaction to the ventilator alarms.					
14	I have an immediate reaction to the infusion pump alarms.					
15	I have an immediate reaction to cardiac monitoring alarms.					
16	In the course of time, my sensitivity to alarms decreases.					
17	I am indifferent to the alarms.					
18	During a CPR in a patient, I become indifferent to the alarms of other patients.					
29	By repetition of alarms, I become indifferent to them.					
20	Multiplicity and concurrence of alarms confuse me in making decisions.					
21	I do not pay attention to the alarm when I do not feel well.					
22	I inactivate the alarms in the night shifts.					
23	I become confused with successive sounds of alarms.					

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