


## ORIGINAL ARTICLE

# The relationships among alarm fatigue, compassion fatigue, burnout and compassion satisfaction in critical care and step-down nurses

Jessica Storm PhD, MSN-ED, RN, Nursing Supervisor<sup>1</sup>  | Hsiu-Chin Chen PhD, RN, EdD, SFHEA, Professor<sup>2</sup>

<sup>1</sup>Einstein Healthcare Network,  
Philadelphia, PA, USA

<sup>2</sup>Department of Nursing, Utah Valley  
University, Orem, UT, USA

**Correspondence**

Jessica Storm, 215 Summer Court,  
Sellersville, 5501 Old York Rd.  
Philadelphia, PA 18960, USA.  
Email: jespatti@comcast.net

**Funding information**

Einstein Healthcare Network

**Abstract**

**Aims and Objectives:** The study purpose was to investigate if compassion fatigue, burnout, compassion satisfaction and personal characteristics are associated with alarm fatigue and predict alarm fatigue in critical care nurses.

**Background:** The phenomena of alarm fatigue, compassion fatigue and burnout place nurses, patients and the healthcare environment in potentially harmful situations and represent the opposite of the foundation of caring and compassion satisfaction in nursing. It has been noted that healthcare organisations should address alarm fatigue as mandated by the Joint Commission based on the higher number of alarms sounding in the critical care environment and based on factors influencing nurses to respond to the alarm.

**Design:** This was a correlational and predictive quantitative study.

**Methods:** The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for research reporting of observational studies was followed in this study. Nurses working in the step-down and intensive care units from three hospitals in a selected healthcare network in Pennsylvania were recruited using convenience sampling ( $n = 52$ ). Observation, the ProQOL and demographic surveys were used to collect data on alarm fatigue, compassion fatigue, burnout, compassion satisfaction and personal characteristics of critical care nurses. Methods of data analyses included descriptive statistics, chi-square, Spearman's  $\rho$  and binary logistic regression.

**Results:** The study results revealed that the participating critical care nurses showed alarm fatigue, were at risk for compassion fatigue and were near risk for burnout.

**Conclusions:** This study illuminated the significant relationships among alarm fatigue and the characteristics of gender, nursing unit, nurse-to-patient ratio and age in critical care nurses.

**Relevance to clinical practice:** The study results can help critical care nurses take the initiative to not only help themselves prevent or overcome alarm fatigue, compassion fatigue and burnout, but also help their coworkers in this area.

**KEY WORDS**

alarm fatigue, burnout, compassion fatigue, compassion satisfaction, critical care, step-down

## 1 | INTRODUCTION

Caring and compassion in nursing care form the foundation to enhance interaction between nurses and patients (Watson, 2011). Compassion satisfaction is the happiness that individuals derive from acting in a manner that is helpful and caring for patients (Stamm, 2005). When nurses provide caring to promote patients' overall health, they may gain a sense of compassion satisfaction. In today's healthcare environments, nurses could feel stressful and burnout due to the overloaded responsibility and demands to provide caring, especially in critical care units (Johnson-Coyle et al., 2016).

Burnout is a state associated with feelings of despair and an inability to cope with the demands of work (Stamm, 2005). Emotional exhaustion, depersonalisation and a decreased feeling of personal achievement also exemplify burnout (Maslach, 1993). The term *compassion fatigue* is used to depict nurses' lack of compassion or empathy or desensitisation to caring for patients (Mooney et al., 2017). Compassion fatigue is a consequence of prolonged exposure to continuous stress and intense patient care that typically occurs in critical care units (Kelly et al., 2015).

With advances in healthcare technology, clinical monitors having alarm functions used in critical care units have skyrocketed. Clinical monitor alarms require a human's response to identify the meaning of the sound and justify the situation based on the patient's needs (Despins, 2017). Often, nurses feel overwhelmed if alarms are simultaneously coming from multiple situations in the critical care unit. It is noted that a monitor giving a false alarm, or an unwarranted sound, has been recognised as a source of stress to healthcare providers (Wilken et al., 2017).

Desensitisation to monitor alarms is known as alarm fatigue (Cvach, 2012). Nurses who care for critically ill patients may endure a greater number of alarms and may experience alarm fatigue along with compassion fatigue or burnout (Petersen & Costanzo, 2017). Compassion satisfaction is the pleasure that nurses gain from being able to provide care to patients without having feelings of exhaustion and desensitisation, which is the antithesis of compassion fatigue and burnout (Stamm, 2005). Because critical care nurses must take immediate actions to respond to an alarm and identify the situation to prevent adverse events, investigating the state of compassion satisfaction, burnout and compassion fatigue among nurses in relation to alarm fatigue is critical to patient safety. Unfortunately, identification of relationships among the above-mentioned phenomena with alarm fatigue in addition to personal characteristics of critical care nurses is lacking.

## 2 | BACKGROUND

Healthcare systems have adopted advanced technology to improve quality of the nursing care environment and patient safety. Applying monitors with alarms in clinical has assisted in maintaining surveillance on patients' vital signs and condition (Shanmugham et al., 2018). For example, some of the multitude of alarms can detect

### What does this paper contribute to the wider global clinical community?

- This study illuminated the significant relationships among alarm fatigue and the characteristics of gender, nursing unit, nurse-to-patient ratio and age in critical care nurses.
- The study results may help critical care nurses take the initiative to not only help themselves prevent or overcome alarm fatigue, compassion fatigue and burnout, but also provide assistance to their coworkers in these areas.

changes in patients' cardiovascular and respiratory functions or prevent falls.

The multitude of alarms along with the potential misinterpretation of false alarms of patients' conditions has spurred the development of alarm fatigue in healthcare providers (Cvach, 2012). Cvach defined *alarm fatigue* as sensory overload in which numerous clinical alarms sounding at once or many frequent false alarms occur to trigger nurses to desensitise the sounds and fail to take actions to meet patients' needs in an appropriate and timely manner. It cannot be overlooked that a clinical monitor's alarms require a human response to acknowledge the alarm and take action to ensure safety and well-being of the patient (Oliveira et al., 2018).

Caring is the root of nursing practice (Adams, 2016). Showing caring to patients displays a nurse's refined ability to assess patients' emotional, mental and physical status and respond to the needs with appropriate interventions (Funk et al., 2018). Compassion satisfaction is the pleasure that a nurse derives from being able to implement quality nursing care and caring for patients (Dunn & Rivas, 2014; Stamm, 2005). However, patients' and families' demanding caring from nurses may result in negative effects on nurses' health and practice such as compassion fatigue and burnout (Jarden et al., 2020).

Compassion fatigue as a condition in which nurses display a lack of compassion or empathy towards patients or are desensitised to caring for patients (Mooney et al., 2017). The phenomenon of compassion fatigue was first introduced after exploring the concept of burnout among emergency room nurses in the 1990s (Coetzee & Klopper, 2010). Burnout is a progressive state in which nurses experience physical, emotional and mental exhaustion as a result of demanding work and great exposure to stressful situations (Maslach, 1993). Stamm (2010) indicated that compassion fatigue is comprised of burnout characterised as exhaustion, frustration, anger and depression, and secondary traumatic stress referred to the negative consequences secondary to fear and work-related trauma.

Critical care units in acute care hospitals provide the highest level of care to critically ill patients and involve a variety of advanced monitors to identify changes in a patient's condition (Despins, 2017). A nurse in a critical care unit must provide continuous care

to patients and work in a stressful, critical and severe healthcare environment. An enormous amount of caring and energy must be exerted to meet the needs of critically ill patients and their families. Because critical care nurses constantly are engaged in caring and dedicate on delivering frequent, intense patient care, they are likely to feel burnout, compassion fatigue, secondary traumatic stress and perceive less compassion satisfaction (Hinderer et al., 2014; Mason et al., 2014).

Nurses' personal characteristics embodied in the nursing care always are present and affect their thought processes and interventions. Kelly et al. (2015) identified that acute care nurses who were ages 21–33 were more likely to experience higher levels of burnout and who had more years of working experience had higher levels of compassion fatigue. Similarly, Sacco et al. (2015) study indicated that female critical care nurses had higher levels of compassion satisfaction compared to male critical care nurses; and critical care nurses over the age of 50 perceived higher levels of compassion satisfaction than nurses in the age groups of 20–29, 30–39 and 40–49. Although literature showed nurses' age, gender and years of working experiences were significantly associated with compassion fatigue, burnout and compassion satisfaction, the impact of several demographic factors such as a nursing unit where employed, shift worked, nurse-to-patient ratio, average hours worked per week and working environments on alarm fatigue are under-researched.

Bonafide et al. (2017) employed observation using video monitoring to assess nurses' reactions to alarms in a paediatric unit and found a median response time of 10.4 min for all observations. In Bonafide et al.'s study, 35 females out of 38 participating nurses had a 1:1 or 1:2+ nurse-to-patient ratio. Nurses with over one-year working experience had a longer response time to the alarms (8.8 min [95% CI, 7.2–10.5]), compared to nurses with less than one-year experience (4.4 min [95% CI, 3.4–5.5]). The response time to alarm for nurses who worked at a 1:1 nurse-to-patient ratio was less (3.5 min [95% CI, 1.3–5.7]) than nurses who had a 1:2 or greater nurse-to-patient ratio (10.6 min [95% CI, 5.3–16.0]).

Alarm fatigue, compassion fatigue and burnout individually are significant factors that may negatively affect how nursing care is provided (Lee et al., 2019; Wilken et al., 2017). It is noted that patient safety and quality of nursing care have been jeopardised by less identifying the impact of alarm fatigue and burnout on managing clinical monitor alarms among nurses. Little research has been conducted on exploring the relationships among alarm fatigue, compassion fatigue, burnout and compassion satisfaction in nurses.

The current study purpose was to examine the relationships among alarm fatigue, compassion fatigue, burnout, compassion satisfaction and personal characteristics of critical care nurses, and identify to what extent compassion fatigue, burnout, compassion satisfaction and personal characteristics can predict alarm fatigue in critical care nurses. The research questions were: (1) What are the relationships among alarm fatigue, compassion fatigue, burnout and compassion satisfaction in critical care nurses? (2) What are the relationships between gender, age, nursing unit, nurse-to-patient ratio, shift worked and alarm fatigue in critical care nurses? (3) What

is the relationship among the year of working experience, average workload per week and alarm fatigue in critical care nurses? and (4) To what extent do compassion fatigue, burnout, compassion satisfaction and personal characteristics of critical care nurses predict their alarm fatigue?

### 3 | METHODS

The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for research reporting of observational studies was followed in this study (University of Bern, 2009) (See Appendix S1).

#### 3.1 | Study design

A correlational and predictive quantitative study using Jean Watson's caring theory (Watson, 2011) was conducted to examine the relationships among alarm fatigue, compassion fatigue, burnout, compassion satisfaction and personal characteristics in critical care nurses. The caring theory has three main concepts including the *caritas* processes, the transpersonal relationship and caring moments, which support how nurses must practice caring to respond to the clinical monitor alarms for promoting safety and well-being of patients. Watson's theory illustrates ideal caring interactions between patients and nurses for developing transpersonal relationships and creating caring moments. Using the caring theory can help illuminate caring and compassion satisfaction are the essential elements to energise nurses' ability to assess the patient's needs and provide quality care. It is hypothesised that highly demanded caring for critical care might cause alarm fatigue, compassion fatigue and burnout among nurses who provide intense critical care to patients.

#### 3.2 | Samples and settings

Convenience sampling was used to recruit critical care nurses from eight intensive care units and four step-down units of three selected medical centres (MC1, MC2 and MC3) in Philadelphia. MC1 has six intensive care units and three step-down units and employs approximately 250 critical care nurses. MC2 offers one intensive care unit and one step-down unit and has approximately 50 critical care nurses. MC3 has one intensive care unit and employs about 50 critical care nurses.

Inclusion criteria for selecting the participants consisted of any registered nurse working in a critical care unit of the three selected medical centres. Critical care units were defined as the intensive care units and step-down units, where clinical monitors were utilised for patients. All registered nurses were recruited for participation regardless of age, gender, race, shift or years worked. The power analysis was conducted to determine the minimum sample size for this study by using the  $\alpha$  level of .05, a statistical power of .8 and a

medium effect size of .3 to produce a minimum sample size of 98. In total, 52 out of 350 registered nurses who worked in four step-down and eight intensive care units at the three selected hospitals within a healthcare network voluntarily participated in this study, after receiving invitation letters, emails and flyers.

### 3.3 | Instrumentation

#### 3.3.1 | Observation

Data on alarm fatigue of critical care nurses were collected through direct observation by designated observers. The operational definition of alarm fatigue used for observation in this study was an elapsed time greater than 10 min between the time a monitor alarm sounds and the time a critical care nurse responds (Bridi et al., 2014). Six observers for recording the elapsed time were the employees of the selected hospitals, who did not work in the selected critical care units. The observers received training of recording the elapsed time and a field test of observation was conducted to examine the inter-rater reliability among the observers. The inter-rater reliability coefficient was  $r = .997$ , which means the observers demonstrated reliable observations.

#### 3.3.2 | The ProQOL

Data of compassion fatigue, burnout and compassion satisfaction were gathered using the Professional Quality of Life (ProQOL) measure developed by Stamm (2005), which is the fifth version originally developed by Charles Figley in 1995. The 30-item ProQOL measure consists of three subscales, including compassion satisfaction, burnout and compassion fatigue. The summated score greater than 33 on the compassion satisfaction subscale indicates the individual may compassionately satisfy with work; the summated score greater than 22 for the burnout subscale means at risk for burnout; the summated score greater than 17 for the compassion fatigue subscale indicates at risk for compassion fatigue (Stamm, 2005).

The ProQOL measure has been determined to be a reliable and valid instrument through previous research (Dikmen et al., 2016; Fahey & Glasofer, 2016; Monroe, 2020; Stamm, 2005). Internal consistency reliability of the ProQOL measure in this current study was examined using Cronbach's  $\alpha$  coefficient. The Cronbach's  $\alpha$  coefficient for the 10-question compassion satisfaction subscale, the 10-question burnout subscale and the 10-question compassion fatigue subscale was .897, .734 and .824, respectively. The Cronbach's  $\alpha$ 's of all subscales in the ProQOL measure exceeded .7, representing an acceptable internal consistency reliability.

### 3.4 | Data collection procedure

After receiving the IRB approval from the selected healthcare network representing the MC1, MC2 and MC3, six observers started collecting

data of the elapsed time on alarm fatigue and compassion satisfaction, burnout and compassion fatigue measured by the ProQOL. All participants signed the consent form. Directed by the observation protocol, each observer was aware of the observation process and documentation of the elapsed time between the time an alarm sounds and the time a nurse enters the patient's room. Each observer had a tip sheet that detailed the responsibilities and a timeline of the process on each observation day. Each observer monitored one to two participants at the same unit within a 12-h shift from either 7 p.m.–7 a.m. or 7 a.m.–7 p.m., depending upon the participant's working schedule.

The principle researcher was available on observation days to answer questions and did spot-checking to ensure consistency of the observation process. Upon completion of observation, the observer provided the demographic survey and the ProQOL measure to the participant in a private area and collected the completed surveys using separate sealed envelopes. In total, 52 observations were completed within 10 weeks.

### 3.5 | Data analysis

The data of alarm fatigue, compassion fatigue, burnout, compassion satisfaction and personal characteristics of the critical care nurses were uploaded into the IBM Statistical Package for the Social Sciences (SPSS) version 24, using a double-entry method. Means, standard deviations, frequency and percentage of the descriptive statistics were computed to identify the variables of personal characteristics of nurses and the levels of compassion fatigue, burnout and compassion satisfaction. Personal characteristics of the participating critical care nurses included age, gender, race, nursing unit where employed, nurse-to-patient ratio, type of shift worked, average workload or number of hours worked per week, and years of working experience. The variables of gender, nursing unit, shift worked and alarm fatigue were all measured on the nominal level.

Based on the research questions, data were analysed using inferential statistics based on the level of measurement for the variables. Spearman's  $\rho$  and chi-squared were used to determine the relationship among alarm fatigue, compassion fatigue, burnout, compassion satisfaction and personal characteristics in critical care nurses. Binary logistic regression was used to examine to what extent compassion fatigue, burnout, compassion satisfaction and personal characteristics predict alarm fatigue in critical care nurses.

## 4 | RESULTS

### 4.1 | Demographics of participants

In total, 52 critical care nurses voluntarily participated in this study and no missing data were identified (See Table 1). Most of the participants were 21–30 years old (40.4%,  $n = 21$ ). The least represented age categories were 41–50 years (7.7%,  $n = 4$ ) and over 60 years (1.9%,  $n = 1$ ). Out of the 52 participants, 82% ( $n = 43$ ) were females

TABLE 1 Summary of demographic variables ( $N = 52$ )

Variable	Frequency	Per cent (%)	Min.	Max.	M	SD
Gender						
Male	9	17.3				
Female	43	82.7				
Age						
21–30 years	21	40.4				
31–40 years	13	25.0				
41–50 years	4	7.7				
51–60 years	13	25.0				
Over 60 years	1	1.9				
Race						
African American	4	7.7				
American Indian	0	0				
Asian	4	7.7				
Caucasian	41	78.8				
Hispanic	2	3.8				
Other	1	1.9				
Nursing Unit where Employed						
Intensive Care Unit	38	73.1				
Step-Down Unit	14	26.9				
Nurse-to-Patient Ratio						
1:1	11	21.2				
1:2	27	51.9				
1:3	12	23.1				
1:4	2	3.8				
Shift Worked						
Day shift (7 a.m.–7 p. m.)	19	36.5				
Night shift (7 p.m.–7 a. m.)	33	63.5				
Average number of hours worked per week			23	86	35.2	8.3
Years of experience			1	50	13.3	12.2

and 79% ( $n = 41$ ) were Caucasian. The majority (73%,  $n = 38$ ) worked in the intensive care units and most of the participants had a 1:2 nurse-to-patient ratio (51.9%,  $n = 27$ ). Only 3.8% ( $n = 2$ ) of the participants worked with a 1:4 ratio. Approximately, 33 participants (63.5%) worked on a night shift. For the average hours worked per week, 51.9% ( $n = 27$ ) of the participants worked 36 h per week. Regarding the years of nursing working experience, the majority reported 2 years (17.3%,  $n = 9$ ) (see Table 1).

## 4.2 | Subscales of the ProQOL

In this current study, the mean of the summated scores of the compassion satisfaction subscale was 41.38 ( $SD = 5.44$ ), indicating that the participants compassionately satisfied with their work (See

Table 2). The mean of the summated scores of the burnout subscale was 21.79 ( $SD = 4.51$ ), showing that the participants were at risk towards burnout. The mean of the summated scores of the compassion fatigue subscale was 21.04 ( $SD = 5.66$ ), showing the participants perceived a feeling of compassion fatigue.

## 4.3 | Alarm fatigue

Based on the elapsed time between an alarm sounds and a nurse enters the patient's room greater than 10 min defined in this study, alarm fatigue was coded as 0 for no alarm fatigue and 1 was for at least one elapsed time greater than 10 min as alarm fatigue for the critical care nurses. Forty per cent of the participants were observed to have alarm fatigue ( $n = 21$ ) whereas 59.6% ( $n = 31$ ) of the

TABLE 2 Summary of the ProQOL subscales (N = 52)

Subscale	Min.	Max.	M	SD
Compassion satisfaction	31.00	50.00	41.38	5.44
Burnout	13.00	33.00	21.79	4.51
Compassion fatigue	13.00	37.00	21.04	5.66

TABLE 3 Summary of alarm fatigue (N = 52)

Variable	Frequency	Per cent (%)
Alarm fatigue	21	40.4
No alarm fatigue	31	59.6

participants did not show alarm fatigue (See Table 3). Of the critical care nurses observed to have alarm fatigue, a greater number of those critical care nurses worked in the ICU (36.8%,  $n = 14$ ) compared to the step-down unit (50.0%,  $n = 7$ ) (See Table 4). Also, of the 21 critical care nurses observed to have alarm fatigue, 11 nurses (33.3%) worked night shift and ten (52.6%) worked day shift. In total, 19 (44.2%) out of 43 females were observed to have alarm fatigue and two (22.2%) out of nine males showed alarm fatigue. Alarm fatigue was shown in 13 critical care nurses aged 21–40 (38.2%) compared to eight nurses aged from 41 and over (44.4%). Approximately, 36.8% ( $n = 14$ ) of the 21 critical care nurses who had alarm fatigue had a 1:1 or 1:2 nurse-to-patient ratio and 50% ( $n = 7$ ) of the nurses had a 1:3 or 1:4 nurse-to-patient ratio.

#### 4.4 | Relationships of alarm fatigue, compassion fatigue, burnout, compassion satisfaction and participants' characteristics

The first research question is 'What are the relationships among compassion fatigue, burnout, compassion satisfaction, and alarm fatigue in critical care nurses?' Because the data of compassion

TABLE 4 Summary of characteristics of alarm fatigue (N = 21)

Variable	Frequency	Per cent (%)
Alarm fatigue in ICU ( $n = 38$ )	14	36.8
Alarm fatigue in step-down ( $n = 14$ )	7	50.0
Alarm fatigue on day shift ( $n = 19$ )	10	52.6
Alarm fatigue on night shift ( $n = 33$ )	11	33.3
Alarm fatigue in males ( $n = 9$ )	2	22.2
Alarm fatigue in females ( $n = 43$ )	19	44.2
Alarm fatigue in ages 21–40 ( $n = 34$ )	13	38.2
Alarm fatigue in ages 41 and over ( $n = 18$ )	8	44.4
Alarm fatigue with 1:1/1:2 nurse-to-patient ratio ( $n = 38$ )	14	36.8
Alarm fatigue with 1:3/1:4 nurse-to-patient ratio ( $n = 14$ )	7	50.0

TABLE 5 Summary of Spearman's  $\rho$  between compassion satisfaction, burnout, compassion fatigue and alarm fatigue (N = 52)

Variable	Alarm fatigue			
	Spearman's $\rho$	$p$	95% C.I.	
			Lower	Upper
Compassion satisfaction	-.045	.754	-.314	.231
Burnout	.054	.705	-.222	.322
Compassion fatigue	.111	.432	-.167	.373

Note: Significance is tested by  $p$  at the .05 level.

fatigue, burnout and compassion satisfaction violated the assumption of normality, Spearman's  $\rho$  correlation for non-parametric statistical tests was run to examine the relationships among compassion fatigue, burnout, compassion satisfaction and alarm fatigue. The results indicated that the variable of alarm fatigue was not significantly correlated with compassion fatigue ( $r = .111$ ,  $CI_{95\%} = -.167$  to  $.373$ ,  $p = .432$ ), burnout ( $r = .054$ ,  $CI_{95\%} = -.222$  to  $.322$ ,  $p = .705$ ) or compassion satisfaction ( $r = -.045$ ,  $CI_{95\%} = -.314$  to  $.231$ ,  $p = .754$ ; see Table 5).

Research question 2 is 'What are the relationships among gender, age, nursing unit, nurse-to-patient ratio, shift worked, and alarm fatigue in critical care nurses?' A series of chi-square statistical test of goodness-of-fit was used to analyse the associations among the study variables. The relationships between the variables of alarm fatigue and gender ( $X^2 = 22.23$ ,  $OR = 2.771$ ,  $CI_{95\%} = .515$ – $14.908$ ,  $p = .001$ ), nursing unit ( $X^2 = 11.08$ ,  $OR = .583$ ,  $CI_{95\%} = .169$ – $2.011$ ,  $p = .001$ ), nurse-to-patient ratio ( $X^2 = 11.08$ ,  $OR = .583$ ,  $CI_{95\%} = .169$ – $2.011$ ,  $p = .001$ ) and age ( $X^2 = 4.92$ ,  $OR = .744$ ,  $CI_{95\%} = .234$ – $2.465$ ,  $p = .027$ ) were statistically significant. The relationship between alarm fatigue and shift worked was not significant ( $X^2 = 3.77$ ,  $OR = .450$ ,  $CI_{95\%} = .142$ – $1.429$ ,  $p = .052$ ; see Table 6).

Research question 3 is 'What are the relationships among the average nursing workload per week, years of working experience, and alarm fatigue in critical care nurses?' Because the data on the variables of average nursing workload per week and years of working experience violated the assumption of normality, Spearman's  $\rho$  correlation for non-parametric statistical tests was run to examine the relationships among the study variables. The variable of alarm fatigue was not significantly correlated with the average nursing workload per week ( $r = .024$ ,  $CI_{95\%} = -.251$  to  $0.295$ ,  $p = .866$ ) or years of working experience ( $r = .017$ ,  $CI_{95\%} = -.257$  to  $0.289$ ,  $p = .905$ ; see Table 7).

Research question 4 is 'To what extent do compassion fatigue, burnout, compassion satisfaction, and personal characteristics of critical care nurses predict their alarm fatigue?' Binary logistic regression statistical test was used to examine which of the independent variables predict the dependent variable of alarm fatigue (See Table 8). In order to prevent Type II error, only the independent variable that was significantly associated with the dependent variable of alarm fatigue was selected to enter the logistic regression model.

**TABLE 6** Summary of chi-square statistical test between personal characteristics and alarm fatigue ( $N = 52$ )

Variable	Alarm fatigue		Odds ratio	95% C.I.	
	Chi-square	$p$		Lower	Upper
Gender	22.23	.001	2.771	.515	14.908
Nursing unit	11.08	.001	.583	.169	2.011
Shift worked	3.77	.052	.450	.142	1.429
Age	4.92	.027	.774	.243	2.465
Nurse-to-patient ratio	11.08	.001	.583	.169	2.011

Note: Significance is tested by  $p$  at the .05 level.

**TABLE 7** Summary of Spearman's  $\rho$  between hours worked, years of experience and alarm fatigue ( $N = 52$ )

Variable	Alarm fatigue		95% C.I.	
	Spearman's $\rho$	$p$	Lower	Upper
Average number of hours worked per week	.024	.866	-.251	.295
Years of experience	.017	.905	-.257	.289

Note: Significance is tested by  $p$  at the .05 level.

**TABLE 8** summary of binary logistic regression between significant personal characteristics of nurses and alarm fatigue ( $N = 52$ )

Variable	S.E.	Wald	df	$p$	Exp(B)	95% C.I. for Exp (B)	
						Lower	Upper
Gender	.871	1.11	1	.292	.399	.072	2.200
Nursing unit	.674	.658	1	.417	.579	.155	2.168
Age	.630	.396	1	.529	1.487	.432	5.113
Constant	.549	.000	1	.992	1.006		

Note: Significance is tested by  $p$  at the .05 level.

According to the results of the above three research questions, the personal characteristics of gender, nursing unit, nurse-to-patient ratio and age were selected as independent variables for running the binary logistic regression test. The results indicated that the variables of gender (Wald (1) = 1.11,  $e^b = .399$ ,  $CI_{95\%} = .072$ –2.200,  $p = .292$ ), nursing unit (Wald (1) = .658,  $e^b = .579$ ,  $CI_{95\%} = .155$ –2.168,  $p = .417$ ) and age (Wald (1) = .396,  $e^b = 1.487$ ,  $CI_{95\%} = .432$ –5.113,  $p = .529$ ) remained in the regression equation but were not significant predictors ( $r^2 = .046$ ) to the variable of alarm fatigue in the sample of critical care nurses.

## 5 | DISCUSSION

This correlational and predictive quantitative study investigated the relationships among alarm fatigue, compassion fatigue, burnout, compassion satisfaction and personal characteristics of critical care nurses. Although the results of this study did not reveal a significant correlation or predictive relationship among the study variables with the alarm fatigue, the research provided valuable insight into all the study phenomena for critical care nurses.

### 5.1 | Demographics of the participants

Fifty-two critical care nurses from the selected healthcare network in Pennsylvania completed the demographic survey. A majority of the participants were female, between the ages of 21 and 40, worked in the intensive care units with a 1:1 or 1:2 ratio for patient care and worked in the night shift. Most of the participants worked about 35 h per week and had approximately 13 years of experience as a registered nurse.

These results of demographic characteristics are consistent with the selected healthcare network's population of critical care registered nurses, as well as with other studies involving intensive care and step-down unit nurses (Kelly et al., 2015; Maiden et al., 2011; Sacco et al., 2015). Kelly et al. (2015) investigated what factors predicted compassion fatigue and compassion satisfaction in acute care nurses where the participants were most female nurses who worked an average of 36 h per week and had an average of 11 years of working experience. In Sacco et al.'s (2015) study regarding compassion satisfaction and compassion fatigue among critical care nurses, the participants were mainly female from the intensive care and step-down units, with the ages of 20–39 and an

average of 15 years of working experience. Demographic results in this study consistent with the literature demonstrate that the participants were like the target population of critical care nurses and can support the generalisation of this current study's results to critical care nurses.

## 5.2 | Compassion fatigue, burnout and compassion satisfaction

Compassion fatigue, burnout and compassion satisfaction are outcomes relevant to caring in nursing (Jakimowicz et al., 2018; Johnson-Coyle et al., 2016; Stamm, 2005). Compassion satisfaction is a positive result of caring, where nurses gain pleasure by providing quality care to patients. Yet, compassion fatigue and burnout can manifest in nurses as irritability, lack of compassion and insensitivity towards work and patients, which are negative results of caring (Dikmen et al., 2016).

In general, this study result indicated that most of the participating critical care nurses possessed compassion satisfaction; unfortunately, they were at risk towards compassion fatigue and near at risk for burnout. The risk for compassion fatigue and burnout can be attributed to nurses' employment in critical care areas. Nurses in critical care units dedicate to providing continuous care for patients in stressful, critical and severe healthcare situations. Because critical care nurses constantly are engaged in providing caring and continuous, intense contact to patients, this population is likely to feel burnout and compassion fatigue (Sacco et al., 2015). The study results are consistent with other studies (Kelly et al., 2015; Sacco et al., 2015) investigating compassion fatigue, burnout and compassion satisfaction among critical care nurses. Kelly et al.'s and Sacco et al.'s studies found that most of the critical care nurses experienced compassion satisfaction but were at risk for burnout and near risk for compassion fatigue.

In a highly stressful and fast-paced environment of critical care units, it is expected that registered nurses may experience compassion fatigue and burnout due to workload and highly demanded nursing care from patients and family (Sacco et al., 2015). In addition to the stressful environment of critical care units, a critical care nurse is usually responsible for caring one to four critically ill patients and may work numerous hours each week on all different shifts. The potential risk for critical care nurses to develop compassion fatigue and burnout in this selected healthcare system should be acknowledged and addressed to avoid negative consequences for nurses and patients.

## 5.3 | Alarm fatigue

Alarm fatigue is a phenomenon characterised by a delayed or lack of response to clinical monitor alarms because of nurses' desensitisation from excessive monitor alarms (Cvach, 2012). Critical care units are the prime location causing alarm fatigue because of busy,

intense and stressful patient care environments along with the presence of various clinical monitors' alarms (Despins, 2017). It is noted that critical care nurses showing decreased responses or delayed response time to clinical monitor alarms can produce severe negative consequences to patients who are already in a severe state (Joshi et al., 2017).

In total, 21 out of 52 critical care nurses observed in this study showed alarm fatigue. Although most of the participants did not display alarm fatigue, over one-third showed alarm fatigue. Considering the Joint Commission (2014) identified alarm fatigue as a concern affecting patient safety and set a national patient safety goal for 2015 that must be addressed, this study demonstrated that alarm fatigue continues to occur in critical care units and should be addressed by nursing leaders.

Like this current study, Bridi et al. (2014) conducted a quantitative study using observation to identify alarm fatigue in intensive care nurses and defined a response time greater than 10 min as the presence of alarm fatigue. Bridi et al. found that nurses' response time to clinical monitor alarms that exceeded 10 min occurred in 60% of all observed alarms, compared to 40% observed alarm fatigue in this current study.

## 5.4 | Relationships among alarm fatigue, compassion satisfaction, burnout, compassion satisfaction and personal characteristics

In this current study, no significant relationships existed between alarm fatigue and compassion fatigue, burnout or compassion satisfaction in critical care nurses, respectively. According to the literature review, no identified previous research has investigated alarm fatigue in relation to compassion fatigue, burnout and compassion satisfaction simultaneously. It is challenging to discuss the study results compared to other studies relevant to alarm fatigue in acute care units. One rationale for the lack of significant results between alarm fatigue and the identified study variables in this current study could be that alarm fatigue was not severe and significant to have an impact on compassion fatigue, burnout and compassion satisfaction at the time period of data collected. However, a significant relationship among the variables may have existed if the sample size can be increased for the study.

In this study, 40% of the participating critical care nurses experienced alarm fatigue and were at risk towards compassion fatigue and near risk for burnout. Relationships among alarm fatigue and compassion fatigue, burnout, compassion satisfaction were assumed based on the premise that clinical monitor alarms require a human response to examine the alarm situation and assess the patient status (Guardia-LaBar et al., 2014). If the critical care nurses experience compassion fatigue and burnout and are desensitised to caring for patients, maybe that will lead to desensitisation to addressing clinical monitor alarms in critical care units.

Relationships among compassion fatigue, burnout and compassion satisfaction have been studied concurrently in numerous



studies using the ProQOL measure (Fahey & Glasofer, 2016; Kelly et al., 2015; Sacco et al., 2015). The negative correlation between compassion satisfaction in relation to compassion fatigue and burnout and a positive correlation between compassion fatigue and burnout have been established in Fahey and Glasofer (2016) and this current study. It is identified that nurses having an increase in compassion satisfaction may display a decrease in burnout and having an increase in compassion fatigue may signify an increase in burnout among nurses. Compassion satisfaction or the pleasure one gains from caring for patients is opposite to burnout and compassion fatigue where nurses experience a decreased sense of personal achievement from caring or are desensitised to caring for patients (Austin et al., 2009; Maslach, 1993; Stamm, 2005). If nurses gain pleasure from their work and compassionately satisfy with caring for patients, then they should not experience increased burnout and fatigue in practice.

The current study results can assist nurse educators in clinical settings to not only identify, but also prevent the problems caused by alarm fatigue, compassion fatigue and burnout in critical care nurses and develop strategies to assist nurses in managing alarm fatigue, compassion fatigue and burnout. Nurse leaders also could develop policies necessitating clinical educators to use observation and tools biannually or annually to identify alarm fatigue, compassion fatigue and burnout in critical care nurses on a routine basis. Once the presence of these issues is identified, the developed policies can mandate clinical educators to educate and mentor nurses to either prevent or overcome these issues for promoting a state of well-being and safe nursing practice.

### 5.5 | Relationships between alarm fatigue and demographic features

In this current study, significant relationships existed between alarm fatigue and gender, age, nursing unit and nurse-to-patient ratio in critical care nurses, respectively. It is noted that a greater number of participants with alarm fatigue were females, were between the ages of 21–40 and had a nurse-to-patient ratio of 1:1 or 1:2. Additionally, 50% of all participating step-down nurses having a 1:3 and 1:4 nurse-to-patient ratio showed alarm fatigue. Of all day-shift nurses who participated, 53% showed alarm fatigue. Based on the above information, it is suspected that younger critical care nurses and nurses working 12-h day shifts may be inclined to developing alarm fatigue. These results are consistent with previous similar studies (Bonafide et al., 2017; Bridi et al., 2014; Deb & Claudio, 2015). It is suggested that nurse leaders might consider alarm fatigue relevant to the impact of nursing units' environments and disease severity of patients for assigning workload to nurses. The finding of a significant relationship between alarm fatigue and the younger age of participants may be attributed to the influx of new graduates into the workforce who may feel overwhelmed with the chaotic environment of the critical care units. Although minimal research exploring alarm fatigue related to personal characteristics of critical care

nurses exists, Bonafide et al.'s (2017) study results support this current study results, which alarm fatigue or response time greater than 10 min significantly correlated with a nurse-to-patient ratio.

This current study implies that nursing leaders must team together with critical care nurses and clinical educators to develop strategies for managing alarm fatigue, compassion fatigue and burnout specific to the needs of the critical care units within the ability of the organisation. The critical results regarding significant relationships among alarm fatigue and gender, nursing unit, nurse-to-patient ratio and age can direct the nurse leader's efforts towards supporting personal characteristics and providing resources to eliminate the factors that might influence patient care in critical care nurses. It is possible that females aged 21–40 years working in the critical care units with a nurse-to-patient ratio up to 1:4 may need resources and mentoring for preventing alarm fatigue.

### 5.6 | Relationships between alarm fatigue, the average hours of workload per week and years of experience

Regarding the relationships between the average hours of workload per week, years of experience and alarm fatigue in critical care nurses, the results showed no significant relationships between the study variables. Little previous research involving the above-mentioned study variables with alarm fatigue exists in the literature. Most research on alarm fatigue focused on examining the clinical monitor alarm settings such as alarm limits and alarm volumes, but not the response time to alarms in relation to the characteristics of the critical care nurses who are responsible for managing the alarms.

When devising this current study, it was based on Bonafide et al.'s (2017) study that the average hours of workload per week and years of working experience would have a significant impact on nurses' ability and decision-making to address clinical monitor alarms. For example, if a typical workload per week is 36 h and a nurse works for 70 h in that week, the nurse may feel overworked to focus on caring practice and to answer alarms in a timely manner. The possible rationale for the non-significant relationships between the average hours worked per week, years of experience and alarm fatigue could be that the average 35.2 h per week and a mean of 13.3 years of experience in this current study were within the regular range to critical care nurses. Also, an average of 13.3 years of working experience among the participants may explain that the nurses were not new to nursing and may have had resources on preventing and managing alarm fatigue.

### 5.7 | Predictors of alarm fatigue

The results for the extent of compassion fatigue, burnout, compassion satisfaction and personal characteristics can predict alarm fatigue indicated no significant predictors to alarm fatigue in the participating critical care nurses. The predictive nature of compassion

fatigue, burnout, compassion satisfaction and personal characteristics of critical care nurses on alarm fatigue previously has not been studied. It was assumed that if critical care nurses had or were at risk for compassion fatigue or burnout, they may significantly be associated with developing alarm fatigue. If the critical care nurses were desensitised to caring or irritable with their work, the nurses may not respond to clinical monitor alarms in a timely manner. This predictive assumption was supported by Deb and Claudio's (2015) quantitative study that used observation to identify nurses' response time to alarms. Deb and Claudio indicated that a nurse-to-patient ratio and nurses' affect characteristics of boredom, apathy and distrust, and nurses' personality traits can influence the response time to alarms.

When using binary logistic regression with multiple predictors, it is important to have substantial samples or a limited number of independent variables for preventing Type II errors. The smaller sample size in this current study may be the possible reason that influenced the results for not having significant predictors to alarm fatigue. It also is possible that the results were influenced by factors such as the organisational culture in the healthcare network not identified in this study. Furthermore, it has been established that most nurses in the selected healthcare system remained employed because of enjoying working with their coworkers and their work. These unstudied factors of organisational cultures may play a role influencing the results and may lead to further research on alarm fatigue. Further research might need to consider variables relevant to leadership, work environments or colleagues' support to draw a firm conclusion on a predictive relationship with alarm fatigue.

## 6 | LIMITATIONS

Limitations of this study included the population, sample, time, instrumentation and sample size. The participants only are representative of nurses in urban and rural Pennsylvania. Generalisation of the study results only should be made to critical care nurses and not to other nursing areas where alarm fatigue or compassion fatigue, burnout or compassion satisfaction may exist. Data collection was conducted over a 10-week period, which might give the participants a chance to speak to other participants regarding the intent of the study. Also, the level of alarm fatigue, compassion fatigue, burnout and compassion satisfaction among participants may be different over periods of time greater than 10 weeks.

With the use of observation for data collection comes the risk of having the Hawthorne effect because behaviours are being watched (McCambridge et al., 2014). It is possible that the study results would be different if the participants were not aware that they were being observed in this study. Fifty-two participants out of 350 critical care nurses in this selected healthcare system representing a participation rate of 16% might limit the study validity.

## 7 | CONCLUSION

The study results revealed that the critical care nurses were at risk for compassion fatigue and near risk for burnout. Even though this

study did not yield significant correlations or predictive relationships of compassion fatigue, burnout, compassion satisfaction, shift worked, average workload per week and years of experience with alarm fatigue, the study did produce significant relationships between alarm fatigue and gender, age, nursing unit and nurse-to-patient ratio of the critical care nurses, respectively. Recommendations for future nursing research on alarm fatigue should consider using a larger sample size, different populations or a mixed methodology to further contribute to the nursing knowledge on alarm fatigue.

## 8 | RELEVANCE TO CLINICAL PRACTICE

This study brought to light the significant relationships among alarm fatigue and the characteristics of gender, nursing unit, nurse-to-patient ratio and age in critical care nurses. Bedside nurses should use the study results to self-reflect their personal characteristics to identify if they are susceptible to alarm fatigue, compassion fatigue or burnout. This study provides cues for nurse leaders to devise and implement strategies and policies to curtail alarm fatigue, compassion fatigue and burnout of critical care nurses. It is suggested that nursing curriculum of undergraduate and graduate nursing programs should prepare new graduates with the resources to manage alarm fatigue, compassion fatigue and burnout. It is critical that nurses take the initiative to not only help themselves prevent or overcome alarm fatigue, compassion fatigue and burnout, but also to assist their coworkers in these areas.

## ACKNOWLEDGEMENTS

Einstein Healthcare Network for financial and material support and for serving as the site for the study.

## CONFLICT OF INTEREST

On behalf of Jessica Storm and Hsiu-Chin Chen, there are no conflicts of interest to declare.

## ORCID

Jessica Storm  <https://orcid.org/0000-0003-1525-6351>

## REFERENCES

- Adams, L. Y. (2016). The conundrum of caring in nursing. *International Journal of Caring Sciences*, 9(1), 1–8.
- Austin, W., Goble, E., Leier, B., & Byrne, P. (2009). Compassion fatigue: The experience of nurses. *Ethics and Social Welfare*, 3(2), 195–214. <https://doi.org/10.1080/17496530902951988>
- Bonafide, C. P., Localio, A. R., Holmes, J. H., Nadkarni, V. M., Stemler, S., MacMurchy, M., Zander, M., Roberts, K. E., Lin, R., & Keren, R. (2017). Video analysis of factors associated with response time to physiologic monitor alarms in a children's hospital. *JAMA Pediatrics*, 171(6), 524–531. <https://doi.org/10.1001/jamapediatrics.2016.5123>
- Bridi, A. C., da Silva, R. C. L., de Farias, C. C. P., Franco, A. S., & dos Santos, V. L. Q. (2014). Reaction time of a health care team to monitoring alarms in the intensive care unit: Implications for the safety of seriously ill patients. *Revista Brasileira De Terapia Intensiva*, 26(1), 28–35. <https://doi.org/10.5935/0103-507X.20140005>

- Coetzee, S., & Klopper, H. (2010). Compassion fatigue within nursing practice: A concept analysis. *Nursing & Health Sciences*, 12(2), 235–243. <https://doi.org/10.1111/j.1442-2018.2010.00526.x>
- Cvach, M. (2012). Monitor alarm fatigue: An integrative review. *Biomedical Instrumentation & Technology*, 46(4), 268–277. <https://doi.org/10.2345/0899-8205-46.4.268>
- Deb, S., & Claudio, D. (2015). Alarm fatigue and its influence on staff performance. *IIE Transactions on Healthcare Systems Engineering*, 5(3), 183–196. <https://doi.org/10.1080/19488300.2015.1062065>
- Despins, L. A. (2017). Factors influencing when intensive care unit nurses go to the bedside to investigate patient related alarms: A descriptive qualitative study. *Intensive & Critical Care Nursing*, 43, 101–107. <https://doi.org/10.1016/j.iccn.2017.04.003>
- Dikmen, Y., Aydin, Y., Basaran, H., Filiz, N. Y., Denat, Y., & Arslan, G. G. (2016). Prevalence of compassion fatigue in emergency and intensive care nurses in Turkey. *Oxidation Communications*, 39(4–1), 3190.
- Dunn, D. J., & Rivas, D. (2014). Transforming compassion satisfaction. *International Journal for Human Caring*, 18(1), 45–49.
- Fahey, D. M., & Glasofer, A. (2016). An inverse relationship: Compassion satisfaction, compassion fatigue, and critical care nurses. *Nursing Critical Care*, 11(5), 30–35. <https://doi.org/10.1097/01.CCN.0000490957.22107.50>
- Funk, L. M., Peers, S., & Roger, K. S. (2018). Caring about dying persons and their families: Interpretation, practice and emotional labour. *Health and Social Care in the Community*, 26, 519–526.
- Guardia-LaBar, L. M., Scruth, E. A., Edworthy, J., Foss-Durant, A. M., & Burgoon, D. H. (2014). Alarm fatigue: The human-system interface. *Clinical Nurse Specialist*, 28(3), 135–137. <https://doi.org/10.1097/NUR.0000000000000039>
- Hinderer, K. A., VonRueden, K. T., Friedmann, E., McQuillan, K. A., Gilmore, R., Kramer, B., & Murray, M. (2014). Burnout, compassion fatigue, compassion satisfaction, and secondary traumatic stress in trauma nurses. *Journal of Trauma Nursing*, 21(4), 160–169.
- Jakimowicz, S., Perry, L., & Lewis, J. (2018). Compassion satisfaction and fatigue: A cross-sectional survey of Australian intensive care nurses. *Australian Critical Care*, 31(6), 396–405. <https://doi.org/10.1016/j.aucc.2017.10.003>
- Jarden, R. J., Sandham, M., Siegert, R. J., & Koziol-McLain, J. (2020). Intensive care nurses' well-being: A systematic review. *Australian Critical Care*, 33(1), 106–111. <https://doi.org/10.1016/j.aucc.2018.11.068>
- Johnson-Coyle, L., Opgenorth, D., Bellows, M., Dhaliwal, J., Richardson-Carr, S., & Bagshaw, S. M. (2016). Moral distress and burnout among cardiovascular surgery intensive care unit healthcare professionals: A prospective cross-sectional survey. *Canadian Journal of Critical Care Nursing*, 27(4), 27–36.
- Joshi, R., Mortel, H., Feijs, L., Andriessen, P., & Pul, C. (2017). The heuristics of nurse responsiveness to critical patient monitor and ventilator alarms in a private room neonatal intensive care unit. *PLoS One*, 12(10), 1–14. <https://doi.org/10.1371/journal.pone.0184567>
- Kelly, L., Runge, J., & Spencer, C. (2015). Predictors of compassion fatigue and compassion satisfaction in acute care nurses. *Journal of Nursing Scholarship*, 47(6), 522–528. <https://doi.org/10.1111/jnu.12162>
- Lee, E., Daugherty, J., Eskierka, K., & Hamelin, K. (2019). Compassion fatigue and burnout, one institution's interventions. *Journal of PeriAnesthesia Nursing*, 34(4), 767–773.
- Maiden, J., Georges, J. M., & Connelly, C. D. (2011). Moral distress, compassion fatigue, and perceptions about medication errors in certified critical care nurses. *Dimensions of Critical Care Nursing*, 30(6), 339–345. <https://doi.org/10.1097/DCC.0b013e31822fab2a>
- Maslach, C. (1993). Burnout: A multidimensional perspective. In W. B. Schaufeli, C. Maslach, & T. Merck (Eds.), *Professional burnout: Recent developments in theory and research* (pp. 19–32). Taylor and Francis.
- Mason, V. M., Leslie, G., Clark, K., Lyons, P., Walke, E., Butler, C., & Griffin, M. (2014). Compassion fatigue, moral distress, and work engagement in surgical intensive care unit trauma nurses: A pilot study. *Dimensions of Critical Care Nursing: DCCN*, 33(4), 215–225. <https://doi.org/10.1097/DCC.0000000000000056>
- McCambridge, J., Witton, J., & Elbourne, D. R. (2014). Systematic review of the Hawthorne effect: New concepts are needed to study research participation effects. *Journal of Clinical Epidemiology*, 67(3), 267–277. <https://doi.org/10.1016/j.jclinepi.2013.08.015>
- Monroe, M., Morse, E., & Price, J. M. (2020). The relationship between critical care work environment and professional quality of life. *American Journal of Critical Care*, 29(2), 145–149.
- Mooney, C., Fetter, K., Gross, B. W., Rinehart, C., Lynch, C., & Rogers, F. B. (2017). A preliminary analysis of compassion satisfaction and compassion fatigue with considerations for nursing unit specialization and demographic factors. *Journal of Trauma Nursing*, 24(3), 158–163. <https://doi.org/10.1097/JTN.0000000000000284>
- Oliveira, A. E. C., Machado, A. B., Santos, E. D., & Almeida, E. B. (2018). Alarm fatigue and the implications for patient safety. *Revista Brasileira De Enfermagem*, 71(6), 3035–3040.
- Petersen, E. M., & Costanzo, C. L. (2017). Assessment of clinical alarms influencing nurses' perceptions of alarm fatigue. *Dimensions of Critical Care Nursing*, 36(1), 36–44.
- Sacco, T., Ciurzynski, S., Harvey, M., & Ingersoll, G. (2015). Compassion satisfaction and compassion fatigue among critical care nurses. *Critical Care Nurse*, 35(4), 32–44. <https://doi.org/10.4037/ccn2015392>
- Shanmugham, M., Strawderman, L., Babski-Reeves, K., & Bian, L. (2018). Alarm-related workload in default and modified alarm settings and the relationship between alarm workload, alarm response rate, and care provider experience: Quantification and comparison study. *Journal of Medical Internet Research*, 20(10), 14. <https://doi.org/10.2196/11704>
- Stamm, B. H. (2005). *The ProQol manual*. Pocatello, ID: Sidran Press. Retrieved from <http://www.compassionfatigue.org/pages/ProQOLManualOct05.pdf>
- Stamm, B. (2010). *The Concise ProQOL Manual 2nd Edition*. Pocatello, ID: The ProQOL.org. Retrieved from <https://proqol.org/uploads/ProQOLManual.pdf>
- The Joint Commission (2014). *Hospital: 2015 national patient safety goals*. The Joint Commission. Retrieved from [http://www.jointcommission.org/hap\\_2015\\_npsgs/](http://www.jointcommission.org/hap_2015_npsgs/)
- University of Bern (2009). *STROBE statement: Strengthening the reporting of observational studies in epidemiology*. University of Bern. Retrieved from <https://www.strobe-statement.org/index.php?id=available-checklists>
- Watson, J. (2011). *Human Caring Science*. Jones & Bartlett.
- Wilken, M., Hüske-Kraus, D., Klausen, A., Koch, C., Schlauch, W., & Röhrig, R. (2017). Alarm fatigue: Causes and effects. *Studies in Health Technology and Informatics*, 243, 107–111.

## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

**How to cite this article:** Storm J, Chen HC. The relationships among alarm fatigue, compassion fatigue, burnout and compassion satisfaction in critical care and step-down nurses. *J Clin Nurs*. 2021;30:443–453. <https://doi.org/10.1111/jocn.15555>