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Research article

Critical care nurses' knowledge of alarm fatigue and practices towards alarms: A multicentre study

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ABSTRACT

Objectives: To determine critical care nurses' knowledge of alarm fatigue (AF) and practices toward alarms in critical care settings.
Research methodology/design: A cross-sectional survey using an adaptation of The Health Technology Foundation Clinical Alarms Survey.
Setting: A sample of critical care nurses (n = 250) from 10 departments across six hospitals in Ireland.
Results: A response rate of 66% (n = 166) was achieved. All hospital sites reported patient adverse events related to clinical alarms. The majority of nurses (52%, n = 86) did not know or were unsure, how to prevent alarm fatigue. Most nurses (90%, n = 148) agreed that non-actionable alarms occurred frequently, disrupted patient care (91%, n = 145), and reduced trust in alarms prompting nurses to sometimes disable alarms (81%, n = 132). Nurses claiming to know how to prevent alarm fatigue stated they customised patient alarm parameters frequently (p = 0.037). Frequent false alarms causing reduced attention or response to alarms ranked the number one obstacle to effective alarm management; this was followed by inadequate staff to respond to alarms. Only 31% (n = 50) believed that alarm management policies and procedures were used effectively.
Conclusion: Alarm fatigue has the potential for serious consequences for patient safety and answering numerous alarms drains nursing resources.

Implications for clinical practice

- Alarm fatigue has the potential for serious consequences for patient safety with the worst-case scenario resulting in death or serious patient harm
- Non-actionable alarms occur frequently and disrupt patient care
- Research regarding alarm fatigue is in its infancy
- Measuring alarm fatigue among critical care nurses should be a priority for nurse researchers

Introduction

Medical devices rely on auditory alarms to alert clinicians to deviations from a predetermined normal status in either equipment or patient. This ensures safeguarding against harm (American College of Clinical Engineering Healthcare Technology Foundation [ACCE HTF], 2007). However, healthcare technology advances have resulted in the exponential growth of medical device auditory alarm sounds (Borowski et al., 2011).

Nurses have become overwhelmed by the sheer volume of alarms leading to alarm apathy (Sendelbach and Funk, 2013).

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The number of alarms has exploded from as many as 171 alarms per monitored bed per day (Graham and Cvach, 2010) and the majority are estimated to be false or in-actionable (Siebig et al., 2010). The technology that has been designed to save lives has therefore been accused of becoming the '*problem*' (Emergency Care Research Institute (ECRI), 2014a,b). This viewpoint is supported by records associating clinical alarms with patient deaths. For instance, Cvach (2012) reviewed the Manufacturer and User Facility Device Experience (MAUDE) database kept by the Federal Drug Administration (FDA) for four months in 2010 finding 73 deaths related to alarms, of which 33 were attributed to physiological monitors. In addition, a search of the MAUDE database discovered 216 deaths related to physiologic monitor alarms, and while alarms sounded in 73 cases, they were not attended due to being silenced, volumes lowered or other reasons (Keller, 2012). Moreover, it is claimed that the actual death rate related to clinical alarms may be ten times higher than declared (The Association for the Advancement of Medical Instrumentation [AAMI], 2011). It is therefore not surprising that up until 2016 the United States (US) patient safety research organisation (ECRI) has positioned alarm hazards as number one, or two, of the annual 'Top 10 Health Technology Hazards' list since it was first devised in 2007. Additionally, alarm management was designated a National Patient Safety Goal in 2014, 2015 and 2016.

Researchers have only recently explored the phenomenon of alarm fatigue (Alsaad et al., 2017; Bonafide et al., 2014; Cho et al., 2016; Deb and Claudio, 2015; Funk et al., 2016; Funk et al., 2014; Gazarian et al., 2015; Honan et al., 2015; Joshi et al., 2017; Ruppel et al., 2018; Varpio et al., 2012). Most of this research emanates from North America. This could partly be explained by different nurse-patient ratios and single occupancy rooms employed in the US compared to elsewhere, rendering the phenomenon more apparent.

Methodology

Research design

This study aimed to determine critical care nurses' knowledge of alarm fatigue and their attitudes, perceptions, and practices towards clinical alarms. A cross-sectional survey design was used.

Instrument

The Health Technology Foundation (HFT) 2011 Clinical Alarms Survey (CAS) (Funk et al., 2014) was used. This instrument consists of four main sections. The first section seeks demographic information including type of hospital and critical care department. The second section consists of general statements about clinical alarms and asks respondents to rate their level of agreement with the statements on a five-point Likert scale (Strongly agree to Strongly disagree). The third section presents a list of nine obstacles to effective clinical alarm management and asks respondents to rank them on a scale of one (most important) to nine (least important). The final section is an open question requesting views on what is needed to improve clinical alarm recognition and response.

Permission was granted from the Health Technology Foundation (HTF) to use the instrument and to make adaptations as necessary. For instance, question 21 was omitted as it pertained to telemetry which is utilised in only two of the study settings. Questions 23 and 30 on the HFT questionnaire were also omitted as they pertained to alarm communication systems and central monitor watchers which are not utilised throughout the study settings. The time frame for question 20, which queried adverse events related to clinical alarms, was changed from '*two*' to '*five*' years to capture whether nurses were knowledgeable about confirmed alarm-related deaths occurring in an intensive care unit (ICU) in Ireland (Geraghty, 2015). Three knowledge questions were added querying nurses' familiarity with the term alarm fatigue, whether they knew what caused alarm fatigue, and how to prevent alarm fatigue. An additional question (Q19) gathered information on the extent to which the practice of customising alarms to patients occurs in practice.

The HFT survey has previously been used to survey healthcare professionals nationally throughout the US in 2005–2006, 2011, and 2016 (Korniewicz et al., 2008: Funk et al., 2014; Ruppel et al., 2018), and also in several other studies to evaluate nurses' perception of alarms (Baird, 2015; Cho et al., 2016; Deb and Claudio, 2015; Sowen at al., 2015; Petersen and Costanzo., 2017; Turmell et al., 2017).

The adapted instrument was pretested among nine critical care nurses and issues with the layout of the survey's nine-point scale were highlighted and subsequently re-organised. A reliability analysis of the adapted instrument generated a Cronbach's Alpha of 0.73.

Ethical considerations

Ethical approval was granted for sites A and B on December 3rd, 2015, site D on January 11th, site C on January 14th, site F on January 16th and site E on March 11th, 2016. Participant confidentiality and anonymity were maintained throughout the study.

Setting

Nurses working at six hospitals in the West of Ireland were surveyed; All were teaching hospitals with university affiliation (Table 1). Five were Model 3 hospitals, which have intensive care facilities on site and emergency departments open 24/7. Site A had Model 4 status as it was the regional tertiary referral centre. Site A was the only hospital with a post anaesthetic care unit (PACU). Nurses at this hospital rotated between the ICU, PACU and high dependency unit, (HDU), therefore, it was deemed appropriate to include PACU in the study despite the short-term nature of this patient population. The small number of PACU nurses 2.87% (n = 8) was not anticipated to affect the data.

Participant selection

Non-probability consecutive convenience sampling was used. Excluding 12 nurses from the single private hospital in the study, the total population included 266 public sector nurses representing 19% of the total public sector critical care staff across Ireland. Excluding non-clinical nurses reduced the target population to 250.

Data collection

The two-page paper instrument was distributed by the first author in person to each site. Data was collected over a one-month period from mid-February to mid-March 2016. A tray of study questionnaires was positioned beside the sealed survey collection box. Respondents were asked to take a survey and return the completed survey to the collection box. Coloured A3 posters were hung in the staff rooms of each site to advertise the study. A champion was recruited for each site to promote the study. The first author collected the sealed box at the end of the data collection period.

Data analysis

Collected data were entered IBM SPSS version 22 for descriptive and statistical analysis. Descriptive statistics were reported as frequency and percentage (%) for categorical data and median

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