

## Stimulus-response time to invasive blood pressure alarms: implications for the safety of critical-care patients



*Tempo estímulo-resposta aos alarmes de pressão arterial invasiva: implicações para a segurança do paciente crítico*

*Tiempo estímulo-respuesta de alarmas de promedio de la presión arterial invasiva: implicaciones para la seguridad del paciente crítico*

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### ABSTRACT

Observational, descriptive, exploratory, case study with the objective of measuring the stimulus-response time of the team to alarms monitoring invasive blood pressure (IBP) and analyzing the implications of this time for the safety of the patient. From January to March 2013, 60 hours of structured observation were conducted with registration of the alarms activated by IBP monitors in an adult ICU at a military hospital in the city of Rio de Janeiro. 76 IBP alarms were recorded (1.26 alarms/hour), 21 of which (28%) were attended to and 55 (72%) considered as fatigued. The average response time to the alarms was 2 min. 45 sec. The deficit in human resource and physical layout were factors determining the delay in response to the alarms. The increase in response times to these alarms may compromise the safety of patients with hemodynamic instability, especially in situations such as shock and the use of vasoactive drugs.

**Descriptors:** Clinical alarms. Fatigue. Patient safety. Intensive care.

### RESUMO

Estudo observacional, descritivo, exploratório, do tipo estudo de caso. Teve como objetivos medir o tempo estímulo-resposta da equipe aos alarmes de monitorização da pressão arterial invasiva (PAI) e analisar as implicações desse tempo para a segurança do paciente. De janeiro a março de 2013, foram realizadas 60 horas de observação estruturada e registro de alarmes disparados por monitores de PAI em uma UTI para adultos de um hospital militar da cidade do Rio de Janeiro. Foram registrados 76 alarmes de PAI (1,26 alarmes/hora), dos quais 21 alarmes (28%) foram atendidos e 55 (72%) considerados fatigados. O tempo médio de resposta aos alarmes foi 2 minutos e 45 segundos. O déficit de recursos humanos e a planta física foram fatores determinantes no retardo da resposta aos alarmes. O alargamento do tempo de resposta a esses alarmes pode comprometer a segurança do paciente com instabilidade hemodinâmica, especialmente em situações de choque e uso de drogas vasoativas.

**Descritores:** Alarmes clínicos. Fadiga. Segurança do paciente. Terapia intensiva.

### RESUMEN

Estudio de caso observacional, descriptivo y exploratorio. Dirigido para medir el tiempo del equipo de estímulo y respuesta a las alarmas de monitoreo de la presión arterial invasiva (PAI) y analizar las implicaciones de este periodo la seguridad del paciente. Desde enero hasta marzo de 2013, hemos llevado a cabo 60 horas de observación estructurada y registro de alarmas disparadas por los monitores de MAP en una UCI de adultos de un hospital militar en la ciudad de Río de Janeiro. Se registraron 76 alarmas PAI (1,26 alarmas / hora), de los cuales 21 alarmas (28 %) fueron ingresados y 55 (72 %) considera fatigado. El tiempo promedio de respuesta fue 2 minutos y 45 segundos. La falta de recursos humanos y la planta física fueron los factores de respuesta tardía a las alarmas. La prórroga del plazo para responder a estas alarmas puede comprometer la seguridad de los pacientes con inestabilidad hemodinámica, especialmente en situaciones de shock y fármacos vasoactivos.

**Descritores:** Alarmas clínicas. Fatiga. Seguridad del paciente. Cuidados intensivos.

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## ■ INTRODUCTION

The measurement and continual monitoring of invasive blood pressure (IBP) are fundamentally important accompanying critical patients, especially during continuous infusion of vasoactive drugs, given its importance<sup>(1)</sup>. The Brazilian consensus for monitoring and hemodynamic support recommends that IBP monitoring be undertaken on patients in hypertensive emergency situations, states of shock, during the use of vasoactive amines, patients during and immediately after cardiac and neurological surgery or other conditions in which hypotension cannot be tolerated or sharp variations in blood pressure<sup>(1)</sup>.

The use of these drugs requires constant vigilance, as small variations in the dose or blood pressure will require immediate professional intervention<sup>(2)</sup>. In this perspective, the multi-parametric monitoring systems enable real time monitoring and alarm systems capable of calling the attention of the team to possible changes in the patient's clinical status.

The development and incorporation of new monitoring equipment and advanced life support at Intensive Care Units (ICU) has been contributing more and more to increasing the number of sound and visual alarms, all with the intention of alerting professionals about the conditions of the patients and faults in the equipment, ensuring the safety and quality of care<sup>(3)</sup>. Around 40 different types of alarms can be heard at intensive care units, especially those generated by monitors (electrocardiogram, respiratory frequency, IBP, pulse oximetry), infusion pumps, dialysis machines, ventilators, etc.<sup>(4)</sup> This amount of alarms, which are not always correct or relevant, provokes a true cacophony of noise, hindering the identification of those that really require an immediate response and consequently increasing the response time of the health team<sup>(5)</sup>. We reiterate that nurses have a prominent role in relation to patient safety, as these professionals spend 24 hours monitoring their condition<sup>(3)</sup>.

Although the alarms are important for saving lives, they may also compromise the safety of the patient when frequently ignored<sup>(3,6)</sup>. This problem gave rise to the concept of "alarm fatigue", a phenomenon frequently observed in ICUs which is characterized by the excessive number of alarm signals, desensitization of professionals and delayed response times<sup>(7)</sup>. The central theme of this study is the phenomenon of alarm fatigue and the objective under investigation is the stimulus-response time of the team to the audio alarms set off by the monitors during invasive blood pressure monitoring.

In 2010 a study demonstrated that 85% of the alarms that occur in the ICU are false or have limited utility<sup>(8)</sup>. False

alarms are irritating and can interfere in care and normally do not result from an adverse event related to it<sup>(7)</sup>. The World Health Organization defines an adverse event as undesirable complications resulting from the care provided to patients, not attributed to the natural evolution of the base disease<sup>(9)</sup>.

In 2012 and 2013 the Emergency Care Research Institute considered alarms as number 1 on its list of 10 hazards for technologies used in healthcare<sup>(6)</sup>. In the national setting, the National Sanitary Surveillance Agency (ANVISA) estimates that one in ten patients attended to at hospitals will suffer some kind of adverse event, such as fall, incorrect administration of medication, identification failures, errors in surgical procedures, infections or misuse of medical devices and equipment. It is estimated that 66.7% of these events are avoidable<sup>(10)</sup>. In this context, in 2013 the Collegiate Directorship published Resolution (RDC) 36/2013 instituting the National Patient Safety Program, with the objective of contributing to improving the care processes and use of health technologies<sup>(10)</sup>.

In 2012, one of the first national works dealing with alarm fatigue was published, studying pulse oximetry alarms at a neonatal intensive care unit<sup>(11)</sup>. In this study 81 alarms (37%) were attended to by health professionals with a maximum time of 14 min. and 43 sec., while another 138 (63%) of alarms were not responded to or were considered as alarm fatigue.

The safety of patients with hemodynamic instability is strongly related to the professional's response time to IBP alarms<sup>(12)</sup>. This study had the objective of measuring the stimulus-response time of the team to alarms activated by the monitor during invasive blood pressure monitoring and analyzing the implications of this time for patient safety at intensive care units. This work is expected to contribute to testing and research in nursing and, above all, to patient safety at intensive care units.

## ■ METHOD

This is an observational, descriptive and exploratory case study based on descriptive statistics for the treatment and organization of data, which was analyzed within the theoretical framework of alarm fatigue and patient safety. The case study is an investigation into an institute that enables phenomenon to be explored but not exhaustively studied, generating hypotheses to be tested in subsequent research<sup>(13)</sup>.

For the collection of data a structured observation technique was used which includes the use of instruments and protocols about what should be observed, the time the obser-

vation should ensure and how the data should be recorded<sup>(13)</sup>. This technique may generate behavioral distortions owing to the presence of the observed, a problem known as “reactivity”<sup>(13)</sup>. The project was approved by the Research Ethics Committee at the Federal University of the State of Rio de Janeiro-UNIRIO on 17/08/2012 under number 76370.

The research was conducted at an adult ICU at a military hospital in the city of Rio de Janeiro. The unit has 14 beds with an occupation rate of 86.01%, attends clinical and surgical patients and counts on a multidisciplinary team composed of physicians, medical residents, medical and physiotherapy students, nurses, nursing technicians, dentists and pharmacist.

In relation to the material resources, all of the bed spaces include multi-parametric monitors, mechanical ventilators, automatic beds and infusion pumps. The monitors are connected to a monitoring station located at the nursing workbench to facilitate the surveillance of patients. When an alarm is activated, the monitor emits a visual and audio alarm. The alarm may be silenced for 2 minutes, but the visual signal will remain on the monitor. Only the visual signal appears on the monitoring station.

In relation to human resources, the nursing team is composed of two nurses and six nursing technicians during day shifts (from 7 am to 7 pm) and one nurse and five nursing technicians on night shifts (from 7 pm to 7 am). The medical team is composed by five physicians in the morning period, and two physicians on duty during the afternoon and nighttime. There is always a resident physician on duty 24 hours per day. There is a physiotherapist at the unit from 7.45 am to 5.15 pm.

The inclusion criteria for the participants were: being on duty at the intensive care unit at the times chosen for observation and agreeing to participate in the study. The inclusion criteria for the beds/patients were: use of invasive blood pressuring monitoring during the onsite observation periods, which occurred between January and June 2013.

Before starting the observation, the professionals in the multidisciplinary team were invited to participate in the study after its objectives were explained. After accepting, they completed the declaration of free and clarified consent, authorizing observation during their work activities in accordance with the ethical and legal precepts inherent in scientific research.

Before starting each observation shift, which took place between 7 am and 7 pm, it was verified which patients were being monitored for invasive blood pressure and if they were using vasoactive medication. The researcher observed and recorded the alarms using the monitoring station at the nursing post. These resources enable the ob-

servations of 14 boxes, given that the visual observation of all beds is not possible at any point in the unit.

When an IBP alarm sounded stimulus-response time was measured with a timer, which was activated as soon as the alarm was activated, and paused when the professional went to the patient’s bed, regardless of the conduct established.

If the alarm stopped before being attended to it was considered as having “no response” and being a case of alarm fatigue. In these situations, the blood pressure values returned to normal values before any intervention by the professional. Alarms that sounded uninterruptedly in the same box and for the same cause that were not attended to within 10 minutes did not have their time restarted but were considered as a single alarm generated. During the observation there was no situation in which two alarms in different boxes sounded at the same time.

Alarms that were not attended to after 10 minutes were also considered as being alarm fatigue. The 10 minute limit was defined considering that when dealing with cardiorespiratory arrest, the greater the response time to the alarm and implementation of actions, the worse the neurological outcome – and there are recommendations for the start of cardiocerebral resuscitation should be less than 4 minutes<sup>(14)</sup>. The definition of this limit has the intention of demonstrating the impact of alarm fatigue, and how this has contributed to enlarging the response time to the alarms beyond that enabling a satisfactory neurological outcome.

## ■ RESULTS

60 hours of observation were conducted during the daily shifts (between 7 am and 7 pm), divided into 19 trips to the site. Thirty-seven professionals agreed to participate in the study: 28 from the nursing team, 05 from the medical team and 4 physiotherapists. The distribution of the number of participants per professional category is presented in Figure 1.

Note that (75%) of the participants are from the nursing team. The significant number of participants in this professional category corroborates the importance of these professionals in patient surveillance and safety<sup>(3)</sup>.

During each observation shift there was an average of eleven patients hospitalized at the ICU, with four (36%) having the IBP monitored. Approximately half of them were surgical patients and used vasoactive medication at the time of observation.

76 alarms for invasive arterial pressure were recorded, generating an average of 1.26 IBP alarms per hour, i.e. ap-

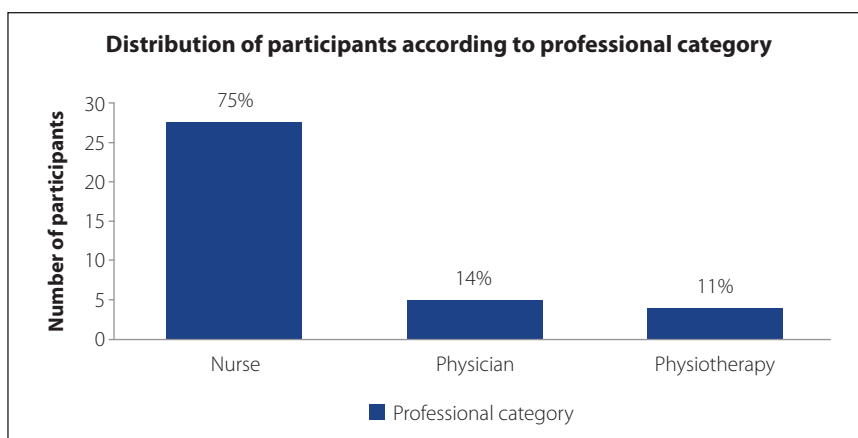
proximately one alarm per hour. 21 (28%) of the alarms were observed, with an average response time of 2.45 min. The lowest response time was 20 seconds and the highest was 8 minutes. Figure 2 demonstrates the IBP alarms that were attended to each minute.

Fifteen alarms (71.4% of the alarms attended to, 20% of the total alarms) were attended to in the first 3 minutes after sounding. This response time seems appropriate to prevent complications in critical patients, however, only 20% of the IBP alarms were attended to in this interval, while the others had a larger response time or were not dealt with.

Fifty-five (72%) alarms were categorized under alarm fatigue, given that they remain without a response for more than 10 minutes, or stopped sounding before the professional could attend to them. The relationship between the alarms attended to and alarm fatigue is illustrated in Figure 3.

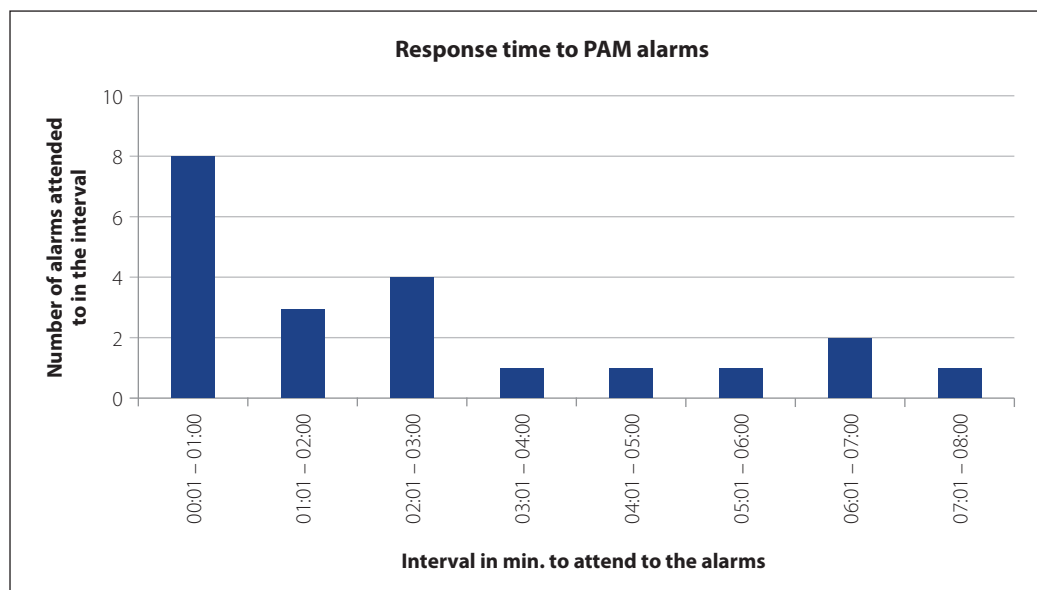
## ■ DISCUSSION

Although the results could, in principle, demonstrate that the number of audio alarms set off at the unit was not



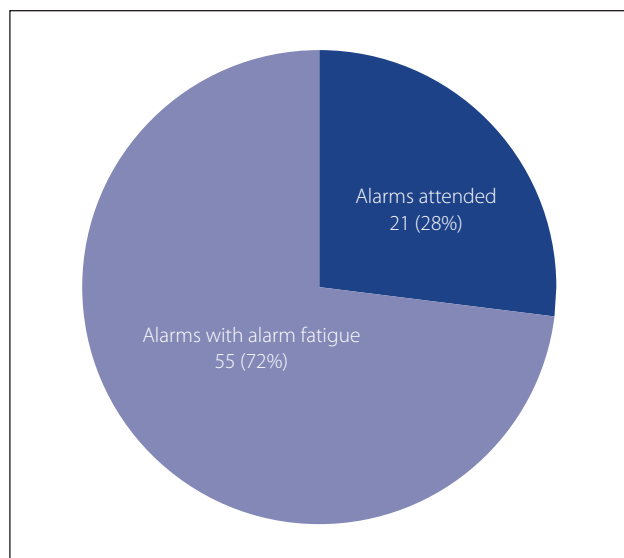
**Figure 1.** Distribution of participants according to professional category. Rio de Janeiro, RJ, January 2013 to March 2013.

Source: Research data.



**Figure 2.** IBP alarms attended to each minute. Rio de Janeiro, RJ, January 2013 to March 2013.

Source: Research data.



**Figure 3.** Number of alarms attended to and alarm fatigue recorded at the unit. Rio de Janeiro, RJ, January 2013 to March 2013.

Source: Research data.

high, we should consider that in this study only those relating to invasive blood pressure were recorded. IBP alarms can vary from 10 to 23% of all alarms set off at the unit by the multi-parametric monitors<sup>(5)</sup>. In this sense, we can discover how common it is for one of these alarms to go off and how this can contribute to raising the number of alarms activated at the ICU.

The risk of occurrences of incidents related to blood pressure variations may be very high, given the elevated number of alarms no responded to (72%), although this is within the average revealed by other studies<sup>(3-7,11,16)</sup>. In individuals with hemodynamic instability rapid intervention is necessary and may change the prognosis and development of symptoms<sup>(14)</sup>. In the case of hypotension, the persistent shock generates an inadequate tissue perfusion, the systems begin to decompensate owing to the lack of blood supply, compromising organs and the patient's failure to respond to treatment<sup>(2)</sup>. Maintenance of a state of shock for more than 24 hours is responsible for a poor prognosis, raising the death rate to 60 to 70%<sup>(14)</sup>. In serious cases of hypertension, there may be damage to target organs, such as encephalopathy, acute myocardial infarction, unstable angina, acute pulmonary edema, eclampsia and stroke<sup>(2)</sup>.

In the occurrence of cardiorespiratory arrest (which could be verified using IBP monitoring), the response time to the alarms becomes imperative, with the recommendation to start maneuvers already in the 1<sup>st</sup> minute increasing the

survival of patients, mainly in relation to neurological damage<sup>(14)</sup>. Permanent neurological damage is the most feared complication of cardiac resuscitation or when it does not take place early. The high energy needs of the brain become especially vulnerable in situations of ischemia, in 5 minutes of complete cerebral anoxia, reducing the oxygen supply to below critical levels, when secondary alterations to ischemia start to develop<sup>(15)</sup>. Neural activity ceases, and if the oxygen supply is not restored the cell dies, causing hypoxic-ischemic brain damage<sup>(15)</sup>. Therefore, taking into consideration that in 5 minutes ischemic damage may already occur, we can consider that the criteria of 10 minutes with no response to classify alarm fatigue is a highly extended time.

Research conducted at a hospital in the city of Rio de Janeiro recoded 227 alarms, resulting in an average of 5.7 alarms per hour. In the daytime service, 64.15% of all alarms observed were categorized as alarm fatigue. The average stimulus-response time was 4 minutes and 54 seconds<sup>(5)</sup>. The author also used the 10 minute criterion as a limit to consider the alarm as being attended to, therefore, our study found similar results when specifically observing IBP alarms. In other research conducted at an ICU with 24 beds in the same city, 17 alarms IBP alarms were recorded, all considered as alarm fatigue, which was concerning to the author in respect to patient safety<sup>(16)</sup>.

It should be reiterated that the alarms are cumulative in the environment and the noise level is negative for patients and the team. Thus, every time there is a delay in the response time to an alarm, it adds to this accumulation as another alarm could be triggered before responding to the previous one.

Some strategies could be used to analyze the errors related to alarms. One of these is a fault tree<sup>(17)</sup> that indicates factors contributing to not respond promptly to an alarm: team too busy to respond; team deliberating ignoring the alarm; not seeing/hearing the alarm; and confusion in the identification of which alarm of which patient is sounding. In the scenario studied, it was possible to observe the presence of all these factors. The first two related to staffing deficits, and the latter to the physical layout and excess noise at the unit.

In relation to the physical layout, it can be noted that there is a difficulty in identifying some beds, which impedes the alarm being heard. All of the monitors are connected to a monitoring station, however, when the alarm goes off at the bed only a visual signal is shown at the station. Thus, the distance between the beds and the nursing post hinders the identification of the alarm that is sounding and consequently a reaction by the professional to correct it and ensure the safety of the patient.

In relation to the personnel deficit, the number on the nursing team at the unit was identified as diverging from that foreseen in RDC nº 26, May 11<sup>th</sup> 2012. This resolution includes a minimum of 01 clinical nurse for every 10 beds or fraction thereof on each shift, and 01 nursing technician for every 02 beds per shift<sup>(18)</sup>. According to the Resolution, this ICU should have a minimum of 02 clinical nurses and 07 nursing technicians on each shift. Therefore, the number is not being complied with at the unit. If we take into consideration the Federal Nursing Council Resolution (COFEN) nº 293/2004 which forecasts 52 to 56% nurses for intensive care, the discrepancy becomes even greater<sup>(19)</sup>.

The professional in the setting studied passes the majority of their time occupied, providing care to patients, frequently interrupting this to render another type of care, such as attending to the alarms. These interruptions to healthcare have a series of consequences, as they interrupt the sequence of planned work, changing the team's work process and interfering in the professional's capacity to concentrate, which can lead to errors<sup>(5)</sup>.

In 2004 a study observed the alarms and conducts in an ICU destined for neonatal patients, and revealed that 16.74 alarms were set off per hour<sup>(20)</sup>. Despite representing different circumstances from a unit for adult patients, it draws attention for taking into consideration the amount of patients and the time required to deal with each alarm. The authors concluded that if the nurses responded to all of the alarms, it would be practically impossible to carry out any other routine task.

Therefore, it is a challenge for the nursing team to respond to all the alarms sounding at the unit, especially when considering the nurse-patient ratio imposed by RDC 26. Therefore, we should seek alternatives that enable safer and more effective use of the alarm systems.

Thus we have demonstrated, as also discussed in the literature, that it is the nursing team that monitors the patients 24 hours and that interacts most with the patient monitoring system and alarms of these systems, and is therefore the category most involved in the alarm fatigue phenomenon<sup>(6-7)</sup>.

## ■ FINAL CONSIDERATIONS

This study was the first experiment with the phenomenon, especially in relation to the occurrence of the phenomenon during invasive blood pressure monitoring. It did not take into consideration, for example, the borderline values that were adjusted for each patient in their monitors, therefore, there could be some relevant situations that were not detected after the activation of audio alarms.

This research, although diagnostic in nature, has the potential for formulating hypotheses that could result in future studies for proposing measures for reducing the number of alarms and, consequently, alarm fatigue. In this sense, the training of the team could be tested, for example, to see if individualized adjustment of the borderline values would present satisfactory results in reducing the number of alarms activated and a positive impact on patient safety.

1.26 IBP alarms were detected per hour, therefore, although these alarms do not represent a large number in the context of the ICU, they concur with the phenomenon of alarm fatigue. This phenomenon has shown itself to be a current issue that has not been widely studied in Brazil. This lack of knowledge could be related to the large number of studies focused on adverse events related to health professionals, instead of those related to the use of technology/equipment and its consequence on patient safety.

The results encountered point out the need for electrical medical equipment to be maintained by all members of the health team. Adequate programming of alarms to the needs of patients needs to be incorporated in the nursing routine, as patient safety is also dependent on this. Unadjusted, disconnected or low volume alarms may lead to adverse events with a very unfavorable clinical outcome. In this context, the deficit in human resources should be considered as a contributing factor not only to alarm fatigue by also patient safety as a whole.

In this study, 72% of the alarms were considered as cases of alarm fatigue, causing concern in relation to patient safety. There is therefore a need to always question if it is necessary and safe for the patient to enable more than one alarm, which may be unnecessary within their clinical diagnosis.

## ■ REFERENCES

1. Dias FS, Rezende E, Mendes CL, Réa-Neto A, David CM, Schettino G, et al. Parte II: monitorização hemodinâmica básica e cateter de artéria pulmonar. *Rev Bras Ter Intensiva*. 2006;18(1):63-77.
2. Cheregatti AL, Amorim CP *Enfermagem em terapia intensiva*. 1. ed. São Paulo: Martinari; 2010.
3. Korniewicz DM, Clark T, David Y. A national online survey on the effectiveness of clinical alarms. *Am J Crit Care*. 2008 Jan;17:36-41.
4. Chambrin MC, Ravaux P, Calvelo-Aros D, Jaborska A, Chopin C, Boniface B. Multicentric study of monitoring alarms in the adult intensive care unit (ICU): a descriptive analysis. *Intensive Care Med* [Internet]. 1999 Dec [citado 2012 nov 20];25(12):1360-6. Available in: <http://link.springer.com/article/10.1007/s001340051082>
5. Bridi, AC. Fatores determinantes do tempo estímulo-resposta da equipe de enfermagem aos alarmes dos monitores multiparamétricos em terapia intensiva:

- implicações para a segurança do paciente grave [dissertação]. Rio de Janeiro (RJ): Programa de Pós-Graduação Mestrado em Enfermagem, Universidade Federal do Estado do Rio de Janeiro; 2012.
6. Cvach M. Monitor alarm fatigue: an integrative review. *Biomed Instrum Technol* [Internet]. 2012 Jul-Aug [citado 2012 nov 20];46(4):268-77 Available in: [http://www.aami.org/publications/BIT/2012/JA\\_alarm\\_fatigue.pdf](http://www.aami.org/publications/BIT/2012/JA_alarm_fatigue.pdf)
  7. Graham KC, Cvach M. Monitor alarm fatigue: standardizing use of physiological monitors and decreasing nuisance alarms. *Am J Crit Care* [Internet]. 2010 Jan [citado 2012 out 15];19(1):28-34. Available in: <http://ajcc.aacnjournals.org/content/19/1/28.full.pdf+html>
  8. Siebig S, Kuhls S, Imhoff M, Gather U, Schölmerich J, Wrede CE. Collection of annotated data in a critical validation study for alarm algorithms in intensive care: a methodologic framework. *J Crit Care* [Internet]. 2010 Mar [citado 2012 nov 20];25(1):128-35. Available in: <http://dx.doi.org/10.1016/j.jcrc.2008.09.0019>
  9. World Health Organization [Internet]. Conceptual framework for the international classification for patient safety: final technical report [and technical annexes]. 2009 [citado 2010 abr 22]. Available in: [http://www.who.int/patientsafety/taxonomy/icps\\_full\\_report.pdf?ua=1](http://www.who.int/patientsafety/taxonomy/icps_full_report.pdf?ua=1)
  10. Ministério da Saúde (BR), Agência Nacional de Vigilância Sanitária. Portaria Nº 529, de 01 de abril de 2013. Institui o Programa Nacional de Segurança do Paciente (PNSP). Brasília (DF); 2012.
  11. Monteiro, JLS. Tempo estímulo-resposta aos alarmes de oxímetros de pulso em unidade de terapia intensiva neonatal: implicações para a segurança do paciente [dissertação]. Rio de Janeiro (RJ): Programa de Pós-Graduação Mestrado em Enfermagem, Universidade Federal do Estado do Rio de Janeiro; 2012.
  12. Pergher, AK. Tempo estímulo-resposta aos alarmes de monitorização invasiva da pressão arterial: contribuições para a segurança do paciente em unidade de cuidados intensivos [dissertação]. Rio de Janeiro (RJ): Programa de Pós-Graduação Mestrado em Enfermagem, Universidade Federal do Estado do Rio de Janeiro; 2013.
  13. Polit DF, Beck CT. Fundamentos de pesquisa em enfermagem: avaliação de evidências para a prática da enfermagem. Porto Alegre: Artmed; 2011.
  14. Ferrari D. Choque. In: Ferrari D. Terapia intensiva moderna [Internet]. São Paulo: IBRATI; 2006. [citado 2013 ago 09]. Available in: <http://www.acls.com.br/livro-uti.htm>
  15. Rech TH, Vieira S R R, BRAUNER JS. Valor da enolase específica do neurônio como indicador de prognóstico pós-parada cardiorrespiratória. *Rev Bras Ter Intensiva*. 2006;18(4): 396-401.
  16. Santos F. O tempo estímulo-resposta na predisposição a fadiga de alarmes de ventiladores mecânicos: implicações para a segurança do paciente [dissertação]. Rio de Janeiro (RJ): Programa de Pós-Graduação em Enfermagem, Universidade Federal do Estado do Rio de Janeiro; 2012.
  17. Hyman, WA, Johnson E. Fault tree analysis of clinical alarms. *J Clin Eng*. 2008 Apr/Jun 33(2):85-94.
  18. Ministério da Saúde (BR), Agência Nacional de Vigilância Sanitária. Resolução – RDC nº 26 de 11 de maio de 2012. Brasília (DF); 2012.
  19. Conselho Federal de Enfermagem (BR). Resolução COFEN-293/2004 de 21 de setembro de 2004. Fixa e estabelece parâmetros para o dimensionamento do quadro de profissionais de enfermagem nas unidades assistenciais das instituições de saúde e assemelhadas. Rio de Janeiro (RJ); 2004.
  20. Bitan Y, Meyer J, Shinar D, Zmora E. Nurses' reaction to alarms in a neonatal intensive care unit. *Cogn Tech Work*. 2004 Nov;6(4):239-46.

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