


BMJ Open Quality **Stats on the desats: alarm fatigue and the implications for patient safety**

Hannah R Anderson,¹ Alex C Borgen,¹ Rebecca Christnacht,¹ Jenny Ng,¹ Joel G Weller,¹ Halley N Davison,² Peter A Noseworthy,³ Rachel Olson,⁴ Danielle O'Laughlin,⁵ Levi Disrud ,² Anthony H Kashou³

To cite: Anderson HR, Borgen AC, Christnacht R, *et al*. Stats on the desats: alarm fatigue and the implications for patient safety. *BMJ Open Quality* 2023;**12**:e002262. doi:10.1136/bmj-oq-2023-002262

Received 13 January 2023
Accepted 7 July 2023



© Author(s) (or their employer(s)) 2023. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

¹Physician Assistant Program, Mayo Clinic, Rochester, Minnesota, USA

²Cardiovascular Research, Mayo Clinic, Rochester, Minnesota, USA

³Cardiovascular Medicine, Mayo Clinic, Rochester, Minnesota, USA

⁴Center for Learning Innovation, University of Minnesota System, Minneapolis, Minnesota, USA

⁵Community Internal Medicine, Mayo Clinic, Rochester, Minnesota, USA

Correspondence to

Mr Levi Disrud;
disrud.levi@mayo.edu

ABSTRACT

Background Physiological monitoring systems, like Masimo, used during inpatient hospitalisation, offer a non-invasive approach to capture critical vital signs data. These systems trigger alarms when measurements deviate from preset parameters. However, often non-urgent or potentially false alarms contribute to 'alarm fatigue,' a form of sensory overload that can have adverse effects on both patients and healthcare staff. The Joint Commission, in 2021, announced a target to mitigate alarm fatigue-related fatalities through improved alarm management. Yet, no established guidelines are presently available. This study aims to address alarm fatigue at the Mayo Clinic to safeguard patient safety, curb staff burnout and improve the sensitivity of oxygen saturation monitoring to promptly detect emergencies.

Methods A quality improvement project was conducted to combat minimise the false alarm burden, with data collected 2 months prior to intervention commencement. The project's goal was to decrease the total alarm value by 20% from 55%–85% to 35%–75% within 2 months, leveraging quality improvement methodologies.

Interventions February to April 2021, we implemented a two-pronged intervention: (1) instituting a protocol to evaluate patients' continuous monitoring needs and discontinuing it when appropriate, and (2) introducing educational signage for patients and Mayo Clinic staff on monitoring best practices.

Results Baseline averages of red alarms (158.6), manual snoozes (37.8) and self-resolves (120.7); the first postintervention phase showed reductions in red alarms (125.5), manual snoozes (17.8) and self-resolves (107.8). Second postintervention phase recorded 138 red alarms, 13 manual snoozes and 125 self-resolves. Baseline comparison demonstrated an average of 16.92% reduction of alarms among both interventions (p value: 0.25).

Conclusion Simple interventions like education and communication techniques proved instrumental in lessening the alarm burden for patients and staff. The findings underscore the practical use and efficacy of these methods in any healthcare setting, thus contributing to mitigating the prevalent issue of alarm fatigue.

INTRODUCTION

Electronic medical devices are commonly employed to monitor patient vitals. Masimo offers non-invasive and continuous monitoring technologies that examine oxygen, pulse rate and perfusion index readings.

These devices emit alarms, which are often non-urgent, potentially false and contribute to the phenomena of 'alarm fatigue'—a desensitisation to alarms. Patient movement, incorrect positioning and premature removal of the device contribute to false alarms. Estimates indicate more than 70% of alarms could be false and obstruct patient safety.¹ Excess noise is deleterious to the patients' therapeutic environment and contributes to agitation and hospital-acquired delirium. Superfluous alarms are injurious to hospital staff concentration, response time and increase psychological stress. Our aim was to decrease the total number of alarms by 20% from 55%–85% to 35%–65%, from January to April 2022. Using key quality improvement methodologies such as the Define, Measure, Analyse, Improve and Control (DMAIC) format, we sought to improve communication, reduce unnecessary SpO₂ monitoring and alarm burdens.

METHODS

Baseline data collection

Masimo continuous monitoring is actively used at Mayo Clinic's main campuses (St. Mary's and Methodist) in Rochester, Minnesota. Nursing staff in the inpatient floors, other than the intensive care units, are typically not standardised to the 1:1 patient care model. As nursing staff may cover up to three or four patients at any given time, these floors may rely on additional staff to help with evaluating patient needs. Masimo allows for flexibility as it can be implemented anywhere within the institution. The baseline alarm metrics were quantified and categorised as manual alarms or resolved alarms (with or without active intervention). The snoozed alarms were manually processed by the technicians when perceived as benign. Using a SIPOC+R methodology in defining the processes, key stakeholders were identified. These stakeholders comprised of monitoring technicians and nursing staff. After

approaching team members from each group, major themes were identified using an Ishikawa cause-and-effect diagram (fishbone tool). Recognition of timely communication was a major concern from both groups.

First intervention

To improve communication, we developed improved signage to indicate policies to all staff members and patients. Previously, minimal information on the SpO₂ carts did not indicate which team(s) should be contacted for diagnostic testing or reattachment. We manually quantified the number of alarms after the new signage was implemented to elucidate any changes through statistical analysis.

Second intervention

Two weeks post implementation, we employed a templated script into the electronic health record. This would prompt nurses to evaluate if patient SpO₂ monitoring remained necessary. The monitoring technicians would review alarm cases for each patient within the past 24–48 hours and examine the following conditions: high/low heart rates, cardiac arrest or significant events that required rapid response teams.

RESULTS

Baseline

At baseline, there was an average of 158.6 red alarms per patient, 37.8 manual snoozes and 120.8 self-resolved alarms. Early data collection showed that patients may alarm 1.5 times within a 2-hour timeframe, showing variances from 55% to 85% of false notifications.

Intervention(s)

After intervention 1, there was an average of 125.5 red alarms per patient, 17.75 manual snoozes and 107.75 self-resolved alarms showing a downward trend. Examining intervention 2, there was an average of 138 red alarms per patient, 13 manual snoozes and 125 self-resolved alarms.

Analysis

Percentage of total alarms snoozed and self-resolved was determined. The means were compared using an unpaired, two-tailed unpaired t-test. Statistical significance was assumed when the p value was <0.05. In comparison to the baseline, there was an average of 16.92% reduction of alarms among both interventions with p value of 0.25. After the implementation of intervention 1, the average number of snooze and self-resolved alarms per patient, per hour, started to have an upward trend. At intervention 1, the p value was <0.05 and at intervention 2, the p value was <0.005 in comparison to baseline data, as represented in figure 1. Interventions implemented over time show gradual downward trending. These results signify that the improvement of snoozed and self-resolved alarms was unlikely due to chance.

CONCLUSION

Alarm fatigue reduction is complex and requires evaluation from multiple perspectives. In fact, some study reports show less than 1%–36% of alarms require actual intervention.² In our efforts to implement a positive change, we can see the potential for downstream effects that range from cognitive load reduction for busy care teams, improved efficiency for care givers, patient outcomes, patients' safety, as well as patient experiences.

The most promising intervention was to reduce the number of patients on continuous monitoring. On evaluating the alarms, we found the quickest response happened in 4min, when a provider discontinued or removed continuous monitoring from a patient. We believe this is due to providers forgetting to discontinue patients when they become stable. Furthermore, identification of several patients being discontinued just minutes before their discharges were seen, which could indicate that patients may have been able to be discontinued earlier, if notified.

Additionally, we noticed that manually snoozed alarms had a downward trend with p value of <0.05 in snoozed alarms and a reduction of total alarms. After our data

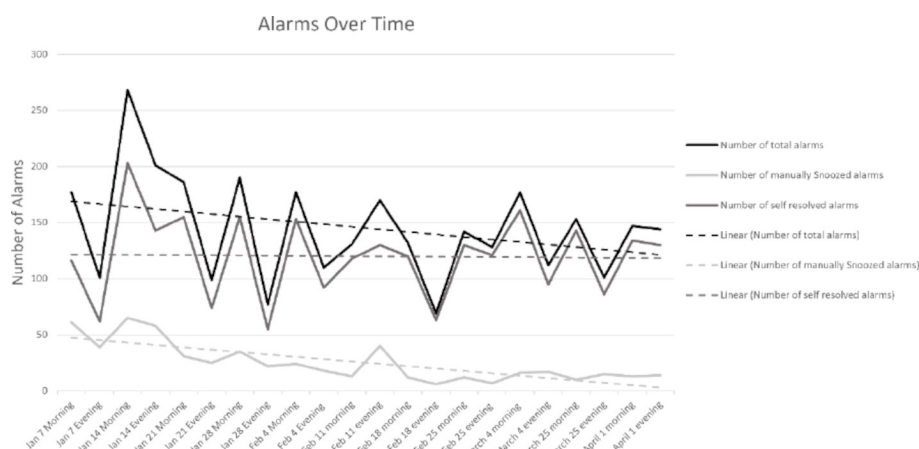


Figure 1 Alarm type(s) demonstrated over time.

analysis, we were unable to discern what prompted this despite its significance. Theories include the technicians could be preoccupied and unable to respond before silenced or resolved, our signage proved effective, patients contacting staff to initiate faster intervention. Though we were unable to attribute exactly what the precipitating agent was, the data were statistically significant.

Although our process was limited by technology, designed workflows and time constraints, our interventions demonstrated a correlative effect of statistical significance. The findings from our interventions were encouraging despite not reaching our goal of a 20% reduction with only a net reduction of 16.9%. The data may not be conclusive, but an action plan had been brought forth for various care teams for immediate and practical use from our findings. Alarm fatigue is a significant problem in healthcare that needs to be addressed to ensure patient safety, decrease staff burnout and improve the sensitivity of SpO₂ monitoring to detect emergencies.

Acknowledgements We would like to thank and acknowledgement Dr Rachel Olson and Danielle O’Laughlin, PAC personally for ongoing work with the Physician Assistant Program at Mayo Clinic. Their guidance, knowledge and passion for improving patient care led to the success of this project. We would also like to show our deep appreciation to Dr Peter Noseworthy and Dr Anthony Kashou for their support.

Contributors Each member shared equal contributorship to this project. Facilitators such as Dr PAN and Dr AHK helped in providing guidance within the clinical setting of the HRPML practice. Dr RO and DO’L, PAC provided guidance in quality improvement strategies.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iD

Levi Disrud <http://orcid.org/0000-0002-4891-4384>

REFERENCES

- 1 Johnson KR, Hagadorn JI, Sink DW. Reducing alarm fatigue in two neonatal intensive care units through a quality improvement collaboration. *Am J Perinatol* 2018;35:1311–8.
- 2 Sendelbach S, Funk M. Alarm fatigue. *AACN Adv Crit Care* 2013;24:378–86.