Alarm Fatigue in the ICU

Firas Alahmad*
Department of Public Health, Ministry of national guard health affairs, Saudi Arabia

*Corresponding author: Firas Alahmad, Department of Public Health, Ministry of national guard health affairs, Saudi Arabia

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Project Overview
Alarm safety is an important element of an intensive care unit. Alarm fatigue occurs when someone is exposed to large number of alarms. Although alarms are necessary in health care setting, most of them need no immediate intervention by the nurse. Dangers of alarm fatigue has become a worldwide concern as evident by multiple international publications. Joint commission raised warning on sentinel event alerts associated to alarm related incidence in 2009 and again in 2012.
The purpose of this project was to explore the clinical alarm situation in our ICU, nurses’ recognition of true and false alarms and the ways to reduce false alarms.
True alarm: Is a true alarm where immediate attention and intervention is required.
False alarms: A false alarm, also called nuisance alarm, causing panic and bringing unnecessary resources to the place where it is not required.
The project owners and the ICU team aimed to reduce alarms by 50% in order to improve patient care and staff desensitization.
The project was conducted on the principles of Six Sigma DMAIC (Define, Measure, Analyze, Improve and Control)

Project Detailed Description
Background
During the project’s “Define” phase, it was identified that 68% of the bedside alarms were nuisance/false alarms. Each of our ICU patients, as well as the ICU nurses, was exposed to a mean of 716 bedside alarms per day, i.e. 30 alarms per hour. According to scientific literature, a total of 350 alarms/day, places the patients at critical risk to develop delirium.

Main Project Objective
To decrease the total ICU bedside alarms by 50% by eliminating false alarms.

Impact
The project commenced in June 2019 and had a total of 820 alarms/patient/day (716 bedside and 104 telemetry). The project’s peak alarm measurement was 3-months into the project and was 1503 alarms/patient/day. Since this peak, and due to project improvement actions, the project demonstrated a consistent trend in alarm declinations to the lowest measured alarms in November 2020 with 226 alarms, a 72% decline from the initial 820 alarms.

Spread and Sustainability
This project’s improvements plans included collaboration with medical device companies, policy creation, staff training and an overall culture shift towards alarm safety awareness. These actions are in keeping with best practice recommendation from international Best-in-Class organizations, thus making this project and its improvement plan replicable to other sites within the Kingdom of Saudi Arabia.

Value and Innovation
This project resulted in reconfiguration of all ICU beside monitors for which an international company representative visited our site, consequently we did not only reduce the number of alarms, but we initiated a new methodology of patient parameter monitoring based on patient-specific profiling. Secondary values also included improved patient-safety culture awareness and also the measurement of the actual alarm decibels as opposed to only the number of alarms.

Engagement
They key stakeholders included the entire Nursing Services as well as the organization’s operational management. The project owner is the ICU CRN (Clinical Resource Nurse) and a small group of ICU super-users were trained as champions to support this project. All ICU nursing staff was trained on the methodology and numerous roundtable and brainstorming sessions were conducted with the end-users. Nursing policy creators and nursing directorate were involved in establishing the final practice mandate upon the evidence generated throughout this project.

To decrease our total ICU bedside alarms by 50%, in order to improve patient comfort and to decrease desensitization of alarm fatigue among the staff

Purpose
The purpose of the KPI Project is to identify and minimise the current clinical alarm situation in our ICU, nurses’ recognition of true and false alarms and the ways to reduce false alarms. True alarm: Is a true alarm where immediate attention and intervention is required.
False alarms: A false alarm, also called nuisance alarm, causing panic and bringing unnecessary resources to the place where it is not required.

Goal
- To minimize the number of false alarms, approximately 68% of our current alarms are categorized as “False Alarms”, by reducing these false alarms the project’s goal will be achieved, i.e. reducing the total number of alarms by 50%.

Scope
- In scope: We are going to measure all the monitor alarms of all patients in ICU for a period of one week.
- Out of scope: Patient’s other alarms like ventilator, iv pump, arterial line and telemetry weak signal were excluded due to minimal data.

Nurse Team Leader: Judith Pienaar
I discovered that Nurses/ Clinicians are Desensitized to Alarms in ICU. Nurses suffer from Alarm fatigue so this could lead to them possibly disabling, Silencing or ignoring the alarms, associated with physiological monitors e.g. Ventilator, cardiac monitor, etc. Nurses are overwhelmed by alarm fatigue.

Dr Junaid Loharia: Alarm/alert fatigue refers to desensitization to safety alerts, and as result ignorance or fail to respond appropriately to such warnings. It is now recognized as a major unintended consequence of the computerization of health care and a significant patient safety hazard. The phenomenon increases with growing exposure to alerts and heavier use of electronic systems.

Staff Nurse 1: Eman
Alarms in the ICU requires our full attention all the times even it is false alarms. That is why it is stressful and wasting of time when you are caring for a critical patient. Most of our patients complain on this. I hope this project will find a solution.

Alarm Rate Collection
Data was collected by primary nurses during period of admission of every patient over a period of one week using visual and auditory inspection and manual counting. The data was extracted from central monitor and entered into MS Excel (Microsoft, Inc.). A specific form was developed for the primary investigator to capture the data in an organized fashion.
Case Argument

How many alarms do WE have?

Each patient is exposed to 716 alarms per day.

i.e. 30 alarms/hr.

“nuisance” alarms occur frequently (81%), disrupt patient care (77%), and can reduce trust in alarms, causing clinicians to disable them

When alarm frequency is high, nurses can become desensitized and develop “alarm fatigue.”

When alarm frequency is high, nurses can become desensitized and develop “alarm fatigue.”
Alarm Fatigue Project ICU NGHA-Dammam

**Opportunity Statement:** Since our ICU is a mixed ICU with all type of patients from pediatric to geriatric with different clinical condition most of them cardiac. Who require a silent atmosphere. Patient comfort and satisfaction to be considered.

**Goal:** To minimize the amount of false alarms thereby to improve patient comfort and reduce desensitization among the staff.

**Team members**
- NM-Khadecjaj
- CRN -Veena
- STAFF NURSES: All nurses in the unit

**Main Scope**
Measurement of total no of alarms - true and false alarms of all patients in ICU for a period of one week.

**Benefits:**
- Decrease workload for staff
- Improve patient comfort
- Positive outcome of patient satisfaction
- Initiative towards “silent ICU”
- To reduce desensitization

**Define**
- Define the problem to create a focused project charter
- Identification of the problem
- Scope of the study
- Formulation of team
- Communication plan
- Data collection

**Measure**
- Measure the as-is performance to understand the process
- Pre trail survey
- Checklist
- Data collection on no. of alarms

**Analyze**
- Analyze the process to verify root causes using data
- Analyse the cause for high alarms
- Analyse the data collected

**Improve**
- Improve the process and implement the best solution
- Training staff
- Value of checklist
- Creation of guidelines
- Sound level

**Control**
- Control the process to maintain the gains
- Track the long term improvement process
- Standardization of plan

**Baseline**
- Based on literature: total of 350 alarms / day / per bed is critical for patients to develop delirium
- Based on the observation: total 820 alarms/day/bed
- Bed side alarms 716/day/bed and Telemetry 104 alarms/bed/day
- About 495 alarms (mean) are false alarms
  
  68% of false alarms

**State conclusion e.g. Total amount of alarms exceeds critical limit**
- Reducing alarm will result into an increase of patient and staff satisfaction
SiPOC

**Process:** Decrease bedside alarms

**Created by:** Veena Lobo

**Date:** 1-02-2019

**Scope:** 6 beds ICU in NGHA-Dammam

**Start:** Alarm is triggered

**Stop:** Alarm situation is ended or action has been taken

**Inputs**
- Protocol
  - ACLS AND PALS guidelines on normal limits
- Connected Equipment (Cardiac monitor, Ventilators, Infusion pumps, Telemetry)
- Clinical competence and knowledge of ICU staff (completion of bedside monitor and alarm limits check list in Best Care per shift)
- Clinical status of the patient

**Process**
- Completion of bedside monitor alarm check list per shift
  - Alarm limits are set
  - Alarm is triggered
  - Nurse takes action
  - Action is taken
  - Staff education

**Outputs**
- Possible action:
  - No action
  - Medical intervention
  - Reset limits
  - Silence limits
  - Call doctor

The process starts when a alarm is triggered and stops when the alarm situation has ended or action has been taken

**Alarm Check List**

![Alarm Check List Image]
Pre-Improvement Status Quo

Total no of alarms/bed/day

Open ICU where all the beds can hear alarms from the other patients. Increase in no. of alarms vary due to unreliability of patient flow and condition

Decibels measured: At the bed side: 73.6dB
From other beds: 65.4dB

• No. of alarms nurse has to attend/day (bedside as well as telemetry)
Bedside Versus Telemetry

Comparison of True and False alarms
False alarms split between bedside and telemetry

![False alarms split between bedside and telemetry](image)
Project Charter

Case Argument
The Joint Commission addresses clinical alarm management issues with National Patient Safety Goal 6 which was effective January 1, 2014. NPSG.06.01.01 requires hospitals and critical access hospitals to improve the safety of clinical alarm systems. This NPSG was implemented in two phases. The second phase of this goal was effective January 1, 2016. Phase II requires accredited hospitals and critical access hospitals to have policies and procedures (https://www.mcnhealthcare.com/safety-of-clinical-alarm-systems/)

Problem Statement
To decrease our ICU bedside alarms by 50%, in order to improve patient comfort and to decrease desensitization of alarm fatigue among the staff.

Goal statement
The goal of this project to minimize the amount of false alarms there by to improve patient comfort and nurses desensitization to alarms

Project Scope:
To improve patient safety and staff desensitization to Alarms.

Project plan
- Define: Identification of the problem, scope and communication plan
- Measure: Use the survey to identify the alarm desensitization, collect no. of alarms/day
- Analyze: Utilized tool to measure pre and post alarm implementation
- Improve: Training of staff, creation of guidelines, assessment of sound level
- Control: Create awareness among the staff

Project team
- NM
- CRN
- STAFF NURSES

Communication Plan
- Creation of pre-survey done on Jot form and communicated to all staff via email
- Completion of central monitor daily check list through best care deployment
- Primary nurse to attend the alarms and if required intervention to communicate to the physician
- Assessed the sound level of alarms
- If sound levels out of range team leader will communicate to the biomed

Central Monitor Nurse Daily Checklist
- Patient Identification Check: Correct MN & Name
- MRN & Name in Electronic documentation, bedside monitor and Central monitor congruent
- Empty Room: Discharged from monitor, patient cleared
- Alarm Parameter set and all alarms are ON
- Arrhythmia alarms, RED “ALL ON” record & store
- Arrhythmia alarms, YELLOW “ALL OFF” set appropriately
- Rhythm analysis done per shift
- Awareness of alarms, sound, and...
**Time Consumption & Waste Reduction**

- Over usage of telemetry for a longer period
- Unnecessary use of telemetry e.g., patient on supportive and comfort care
- Renewal of telemetry every 48hrs as per DPP
- Staff not setting alarm limits at the beginning of the shift
- Number of false alarms which are high compared to true alarms

No official/sufficient guidelines on alarm setting and changes

### Investigate Outliers

- This quality improvement project finds a statistically significant decrease in total alarms after the implementation of the educational session and reviewing clinical alarm checklist in Best care and changing of patient profile in the cardiac monitors.

<table>
<thead>
<tr>
<th>Stakeholder group</th>
<th>Audience</th>
<th>Message(s)</th>
<th>Media/Vehicle</th>
<th>Frequency</th>
<th>Timing</th>
<th>Responsibility (to do this communication)</th>
<th>Feedback Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Primary nurse</td>
<td>• All staff of ICU</td>
<td>• Completion of alarm check list per shift</td>
<td>• Training</td>
<td>• Documentaion done every shift</td>
<td>• With in first hour of shift</td>
<td>• Primary nurse</td>
<td>24hrs chart review</td>
</tr>
<tr>
<td>• Physicians</td>
<td></td>
<td>• Setting of alarm limits /shift</td>
<td>• Verbal</td>
<td></td>
<td></td>
<td>Telemetry assigned nurse</td>
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</tr>
<tr>
<td>• Nurse Manager</td>
<td></td>
<td>• Changing of electrodes every 24hrs</td>
<td></td>
<td></td>
<td></td>
<td>Team leader</td>
<td></td>
</tr>
<tr>
<td>• Team leader</td>
<td></td>
<td>• Proper skin preparation before the placement of electrodes</td>
<td></td>
<td></td>
<td></td>
<td>Clinical Resource Nurse</td>
<td></td>
</tr>
<tr>
<td>• Biomed</td>
<td></td>
<td>• Check the sound level</td>
<td></td>
<td></td>
<td></td>
<td>Nurse manager</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk</th>
<th>Yes</th>
<th>No</th>
<th>Mitigation</th>
</tr>
</thead>
</table>
| Desensitization to alarms | Yes | | • Staff education
  • Alarm limit setting should be done according to patient condition and age specific.
  • Patient profile to be selected according age specific |
| Delirium           | No  |    |             |
| Jeopardizing patient safety | No |    |             |
### C&E Metric

<table>
<thead>
<tr>
<th>2. Rate importance of each output to the nurse →</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. List outputs →</td>
<td>Staff fatigue</td>
<td>Delirium</td>
<td>Red alarms</td>
<td>Device</td>
</tr>
<tr>
<td>3. List inputs ↓</td>
<td>4. Rate the strength of the relationship - the effect of each input on each output ↓</td>
<td>5. Prioritize on total score ↓</td>
<td></td>
<td></td>
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<tr>
<td>Assessment</td>
<td>10</td>
<td>3</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Knowledge</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Policy</td>
<td>3</td>
<td>1</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Patient condition</td>
<td>8</td>
<td>5</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Patient acuity</td>
<td>8</td>
<td>1</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Patient ratio</td>
<td>8</td>
<td>1</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Patient population</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

### Mitigation

**Central Monitor Nurse Daily Checklist**

- **Patient Identification Check**
  - Correct MRN & Name
  - Done: 🔴, Not Done: 🟡, N/A: 🔴

- **MRN & Name in Electronic documentation, Bedside monitor and Central monitor correspond**
  - Done: 🔴, Not Done: 🟡, N/A: 🔴

- **Empty Room: Discharged from monitor, sector cleared**
  - Done: 🔴, Not Done: 🟡, N/A: 🔴

- **Alarm Parameter set and all alarms are ON**
  - Done: 🔴, Not Done: 🟡, N/A: 🔴

- **Arrhythmia alarms, RED “ALL ON” record & store**
  - Done: 🔴, Not Done: 🟡, N/A: 🔴

- **Arrhythmia alarms, YELLOW “ALL ON” set appropriately**
  - Done: 🔴, Not Done: 🟡, N/A: 🔴

- **Rhythm analysis done per shift**
  - Done: 🔴, Not Done: 🟡, N/A: 🔴

- **Arrhythmia rhythm sound and record**

![Image of monitor and checklist]
Run chart rules:
Shift: None
Trend: No upwards, nor downward trending
Runs: 4 Runs. NB: Require more useful data points to ensure correct run interpretation.
Astronomical points: Fulfill lower limit requirements
Interpretation: The run chart signifies “common cause variations” (i.e. the variations are unassignable, random, variations), thus process changes are called for at this stage.
This interpretation confirms the common cause variation for the total alarms.
## Risk Assessment & Mitigation

<table>
<thead>
<tr>
<th>Risk</th>
<th>Yes</th>
<th>No</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covid patients - time consumed to were PPE</td>
<td>YES</td>
<td></td>
<td>Monitoring amount of time required to were PPE</td>
</tr>
<tr>
<td>Procedure related (Prone position)</td>
<td>Yes</td>
<td></td>
<td>To check the leads before procedure</td>
</tr>
<tr>
<td>Deteriorating patients</td>
<td>Yes</td>
<td></td>
<td>Attend the alarms</td>
</tr>
<tr>
<td>Restless patient</td>
<td>Yes</td>
<td></td>
<td>Set low limits</td>
</tr>
<tr>
<td>Staff ignorance</td>
<td></td>
<td>NO</td>
<td>Sitter if needed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Restrain</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Anxiolytic medication</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Webinar video call with family</td>
</tr>
</tbody>
</table>

### Noise Level in ICU
- How loud the alarms at bed side:
- The World Health Organization (WHO) recommends that noise levels in the hospital environment should not exceed 35 decibels (dB) during the night and 40 (dB) during the day [1-4]. However, the American Conference of Governmental Industrial hygienist (ACGIH) stipulate that noise levels in the workplace should not go beyond 85 dB [5].

### IABFH-ICU Setting
- At the bed side: 73.6dB
- Other bed side: 65.4dB
- 24hrs round a clock sound level was recorded using decibel. Peak level was 116.8Db at 16:20 which is during visiting time, minimum was recorded 46Db at 23:46hrs. Average sound level was 65.1Db which is safer according to American Conference of Governmental Industrial hygienist (ACGIH).

### Result of the Survey

![Survey Results Chart]

- **Strongly agree**
- **Agree**
- **Neutral**
- **Disagree**
- **Strongly disagree**
Route Cause Analysis for Increase in Alarms

For the month of June there was increase in no. of False Alarms. After analyzing 46% of the false alarms were from Telemetry patients and many of them were COVID patients were in and out was minimized and control of alarms was difficult.

Summary and Objectives

**Highlights:**
- Staff actively participated in the pre survey
- Alarm setting was done daily per shift
- Various profile setting was installed in the monitor
- Telemetry alarm sound was removed from bedside monitors

**Lowlights:**
- Assessment of audible sound was not measured initially
- Data collection tool needed modification
- Some alarms were not able to fix
- Telemetry patients’ alarms are still a issue

References

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4756058/ (ambient noise ref)
2. https://pdfs.semanticscholar.org/762f/fcc1d5e1705cf83a-985f573ee03e5ac51a79.pdf
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3377030/
8. https://pdfs.semanticscholar.org/762f/fcc1d5e1705cf83a-985f573ee03e5ac51a79.pdf