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Case Report

Alarm Fatigue in the ICU

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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.

The downward trend for the last 4 months demonstrated a decrease in total alarms by: 22%, 42%, 48% and 72%.

Spread and Sustainability

This project's improvement 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.

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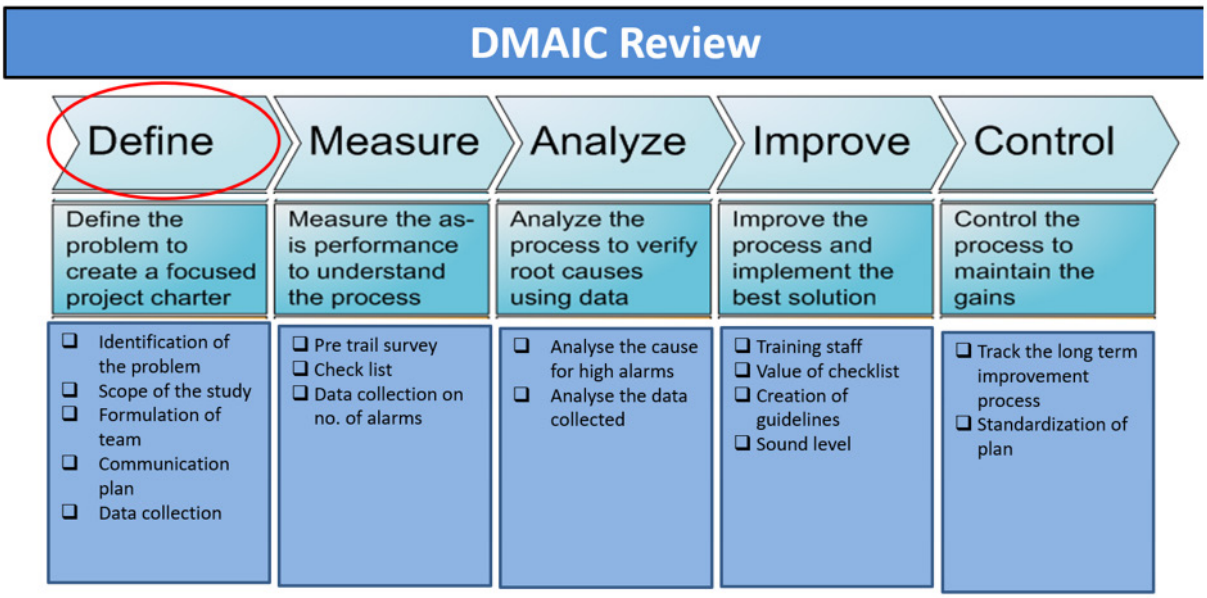

False alarms: A false alarm, also called nuisance alarm, causing panic and bringing unnecessary resources to the place where it is not required.

Goal

- To minimize the number of false alarms, approximately 68% of our current alarms are categorize 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 organize 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

Reliance on pl… monitors to continuously "watch" patients and to alert the nurse … meters are exceeded or a serious rhythm problem occurs is stand… intensive care, progressive care, and telemetry units. Alarm fatigu… when the sheer number of monitor alarms overwhelms clini… cian… nately, could compromise patients' safety if alarms are disabled, silenced, or ign… ological monitors are only as reliable as the clinicians who use them. Nurses … with monitors must be knowledgeable about their physiological monitoring … and how to appropriately tailor parameters for monitor alarms to meet the specifi… of each patient.

Wh… n frequency is high, nurses are at risk for bec… desensitized to the alarms that are intended … protect their patients. Cardiac monitor algorit… are intentionally set for high sensitivity at the … nse of specificity. As a result, numerous false a… ns occur.[1] A 2006 American College of Clinica… gineering survey of more than 1,300 health … e professionals showed that a large percentage … of respondents believed that what are commonly called "nuisance" alarms occur frequently (81%), disrupt patient care (77%), and can reduce trust in alarms, causing clinicians to disable them (78%).[1] In other studies,[2-4] researchers have reported a high percentage (86%-99.4%) of false-positive alarms produced by physiological monitors, stating that alarms result in a change in the management of the patient less than 1% of the time.

The probability of responding to an alarm is lower if the false-alarm rate is high, and alarms in nurses in a 950-bed, northeastern academic medical center. An interdisciplinary alarm management task force was created and charged with (1) evaluating excessive equipment alarms that obscure and desensitize clinicians, (2) standardizing the hospital's approach to alarm management, (3) assessing the reliability of secondary or adjunct alarm notification devices, (4) determining the educational needs of clinicians regarding alarm management, and (5) assessing new technology and systems that may improve alarm management. The purpose of this article is to describe a unit-based quality improvement initiative that enabled the task force to quantify the frequency of cardiac monitor alarms on a single unit and to perform small tests of change to improve management of monitor alarms.

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."

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Alarm Fatigue Project ICU NGHA-Dammam

Project

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.

how did you get to this "Opportunity & Goal" e.g. Observations & interviews

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/be 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

Project team & Scope

Team members

NM-Khadeejah

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

State main scope

Project benefits

Benefits:

- Decrease workload for staff
- Improve patient comfort
- Positive outcome of patient satisfaction
- Initiative towards "silent ICU"
- To reduce desensitization

Reducing alarm will result into an increase of patient and staff satisfaction

DMAIC Review

Define	Measure	Analyze	Improve	Control
Define the problem to create a focused project charter	Measure the as-is performance to understand the process	Analyze the process to verify root causes using data	Improve the process and implement the best solution	Control the process to maintain the gains
❑ Identification of the problem ❑ Scope of the study ❑ Formulation of team ❑ Communication plan ❑ Data collection	❑ Pre trail survey ❑ Check list ❑ Data collection on no. of alarms	❑ Analyse the cause for high alarms ❑ Analyse the data collected	❑ Training staff ❑ Value of checklist ❑ Creation of guidelines ❑ Sound level	❑ Track the long term improvement process ❑ Standardization of plan

sIPOc

Process: Decrease bedside alarms	Scope: 6 beds ICU in NGHA-Dammam
Created by: Veena Lobo	Start: Alarm is triggered
Date: 1-02-2019	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 bed side monitor and alarm limits check list in Best –Care per shift)
- Clinical status of the patient

Process

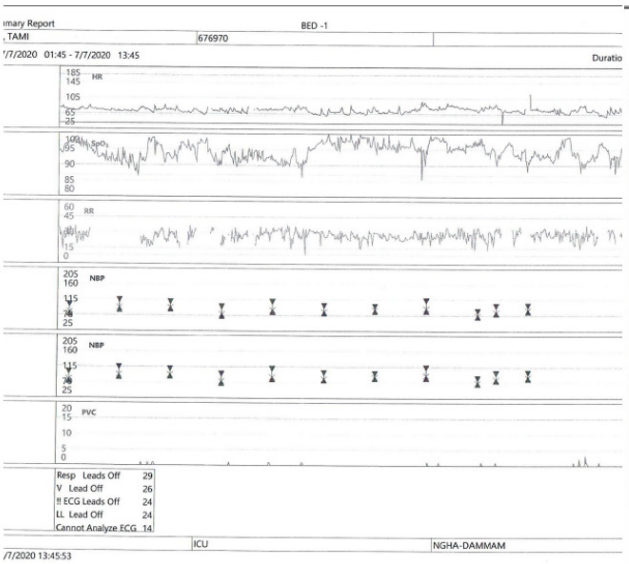
- Completion of bedside monitor alarm check list per shift
- Alarm limits are set
- Alarm is triggered
- Nurse takes action
- Action is taken
- Staff education

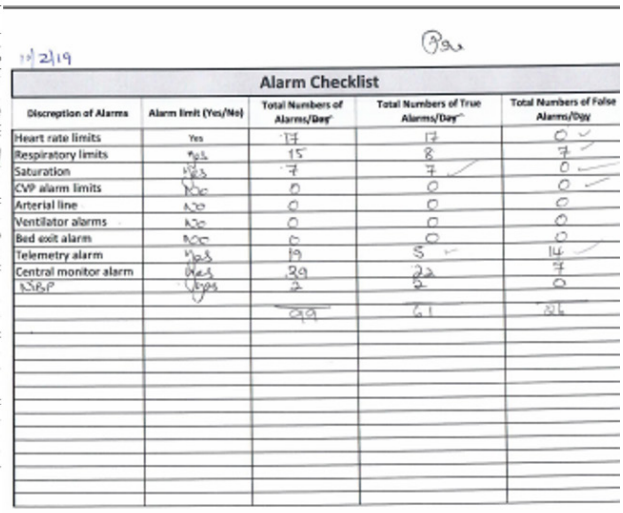
Outputs

- Possible action:
- No action
- Medical intervention
- Reset limits
- Silence alarm
- 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

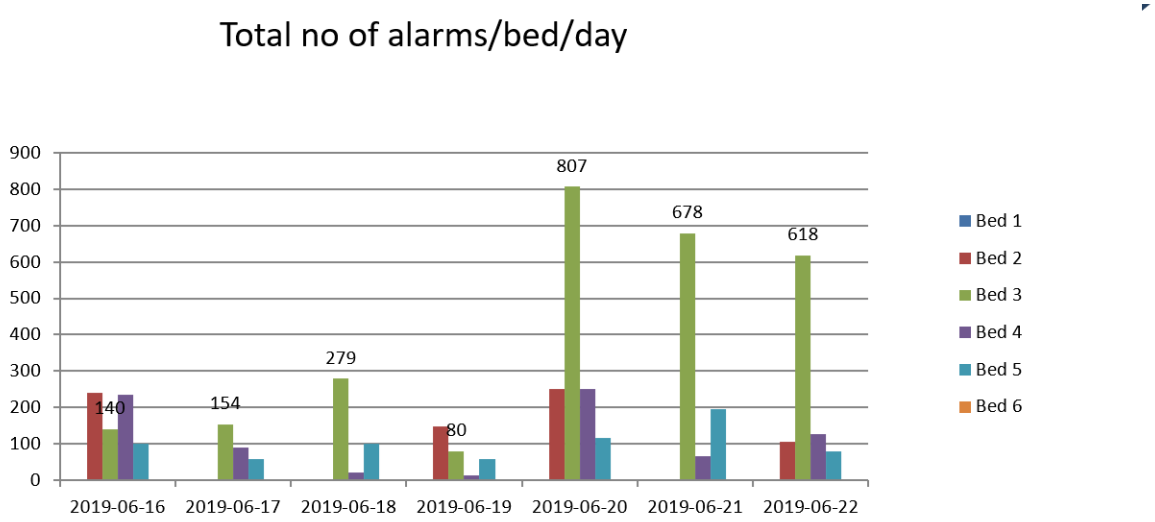




Alarm Checklist

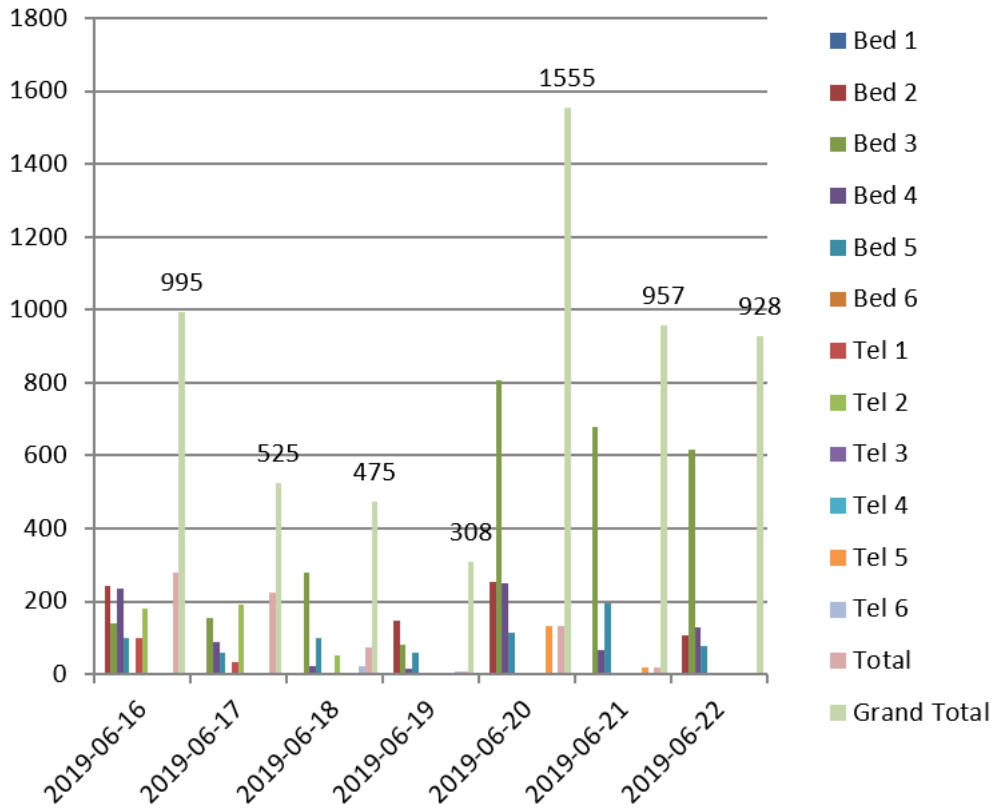
Discreption of Alarms	Alarm limit (Yes/No)	Total Numbers of Alarms/Day	Total Numbers of True Alarms/Day	Total Numbers of False Alarms/Day
Heart rate limits	Yes	17	17	0
Respiratory limits	Yes	15	8	7
Saturation	Yes	7	7	0
CVP alarm limits	No	0	0	0
Arterial line	No	0	0	0
Ventilator alarms	No	0	0	0
Bed exit alarm	No	0	0	0
Telemetry alarm	Yes	19	5	14
Central monitor alarm	Yes	29	22	7
RSBP	Yes	2	2	0
		29	61	28

Pre-Improvement Status Quo

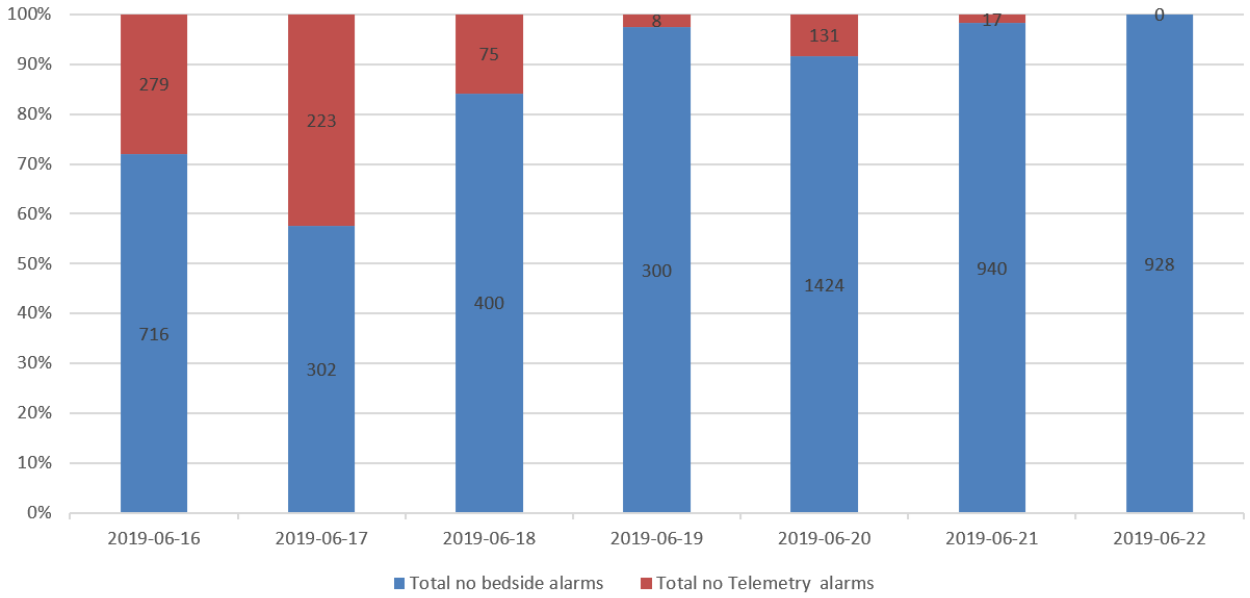


Open ICU where all the beds can hear alarms from the other patients.
Increase in no.of alarms vary due to unreliability of patient flow and condition
Decibels measured: At the bed side:73.6dB
From other beds:65.4dB

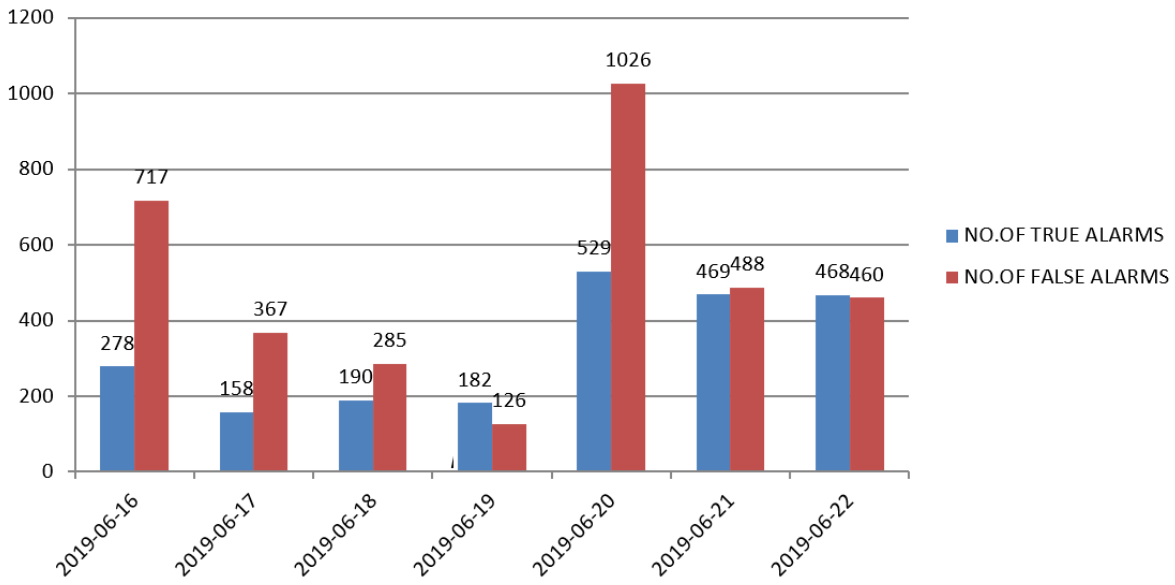
•No. of alarms nurse has to attend/day (bedside as well as telemetry)



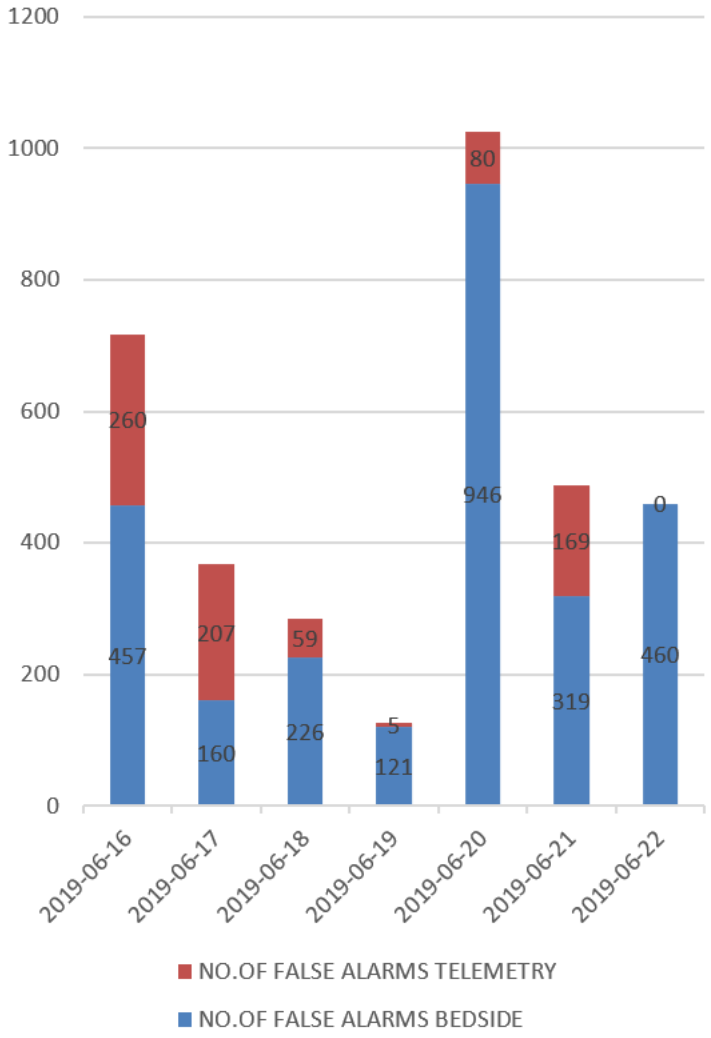
Bedside Versus Telemetry



Comparison of True and False alarms



False alarms split between bedside and telemetry



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

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

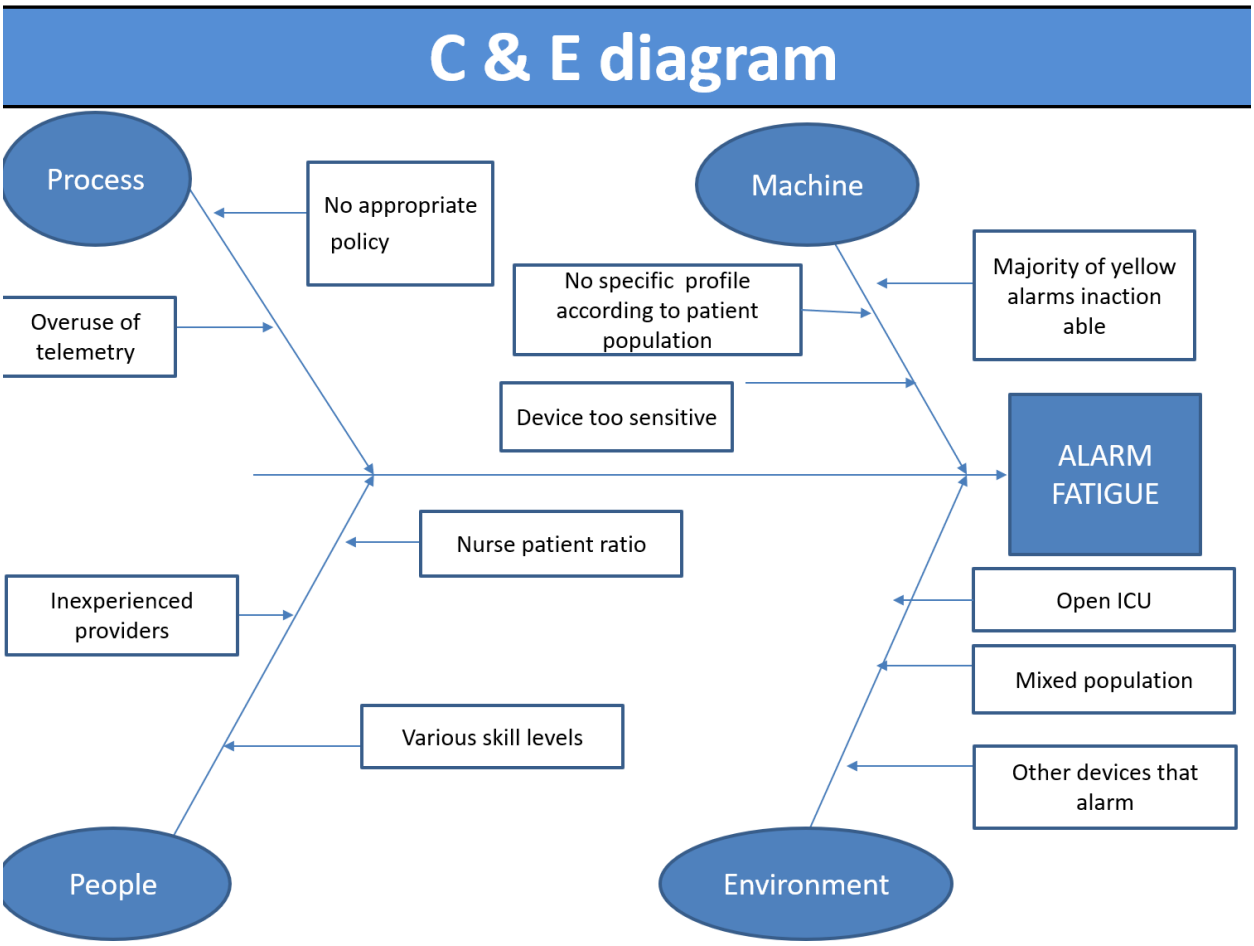
Time Consumption & Waste Reduction

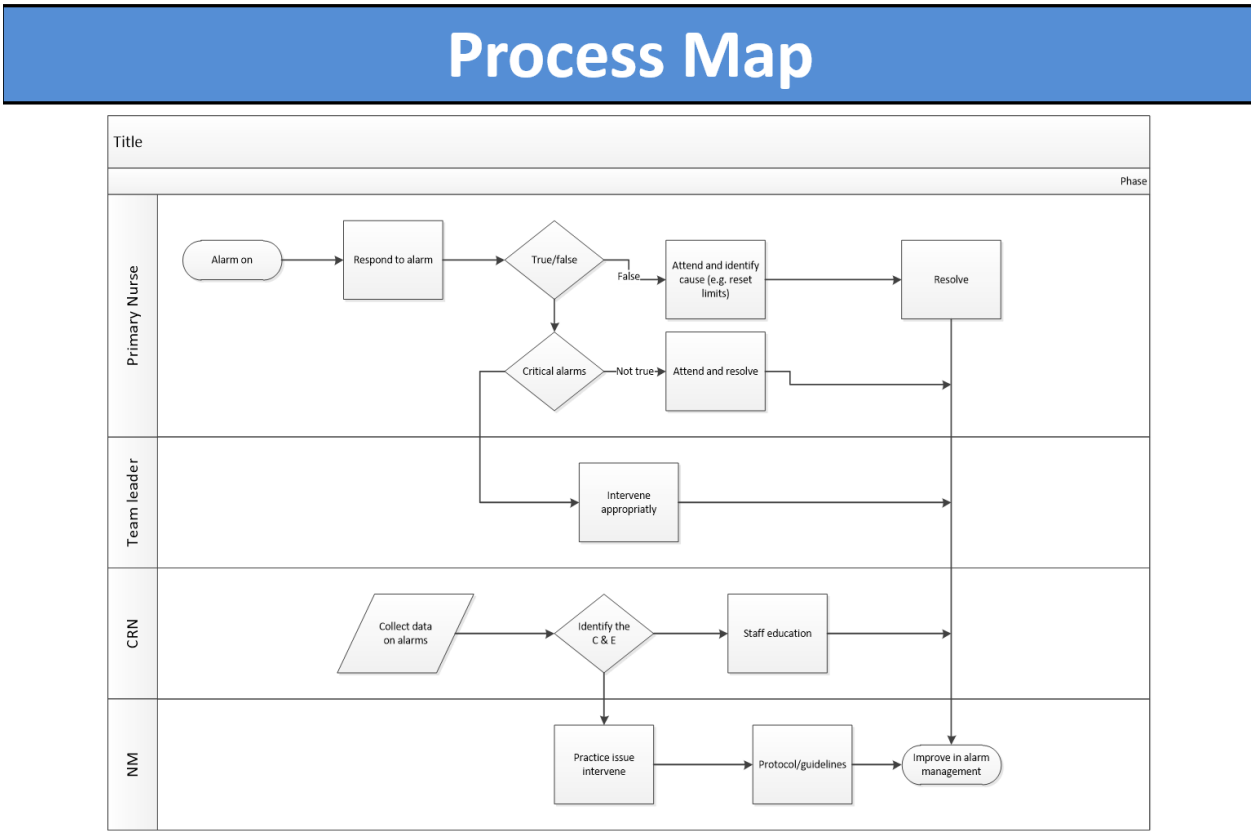
•Over usage of telemetry for a longer period
•Unnecessary use of telemetry e.g., patient on supportive and comfort care
•Renewal of telemetry every 48hrs as per DPP
•Staff not setting alarm limits at the beginning of the shift
•Number of false alarms which are high compared to true alarms
No official/sufficient guidelines on alarm setting and changes

Risk	Yes	No	Mitigation
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	

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.

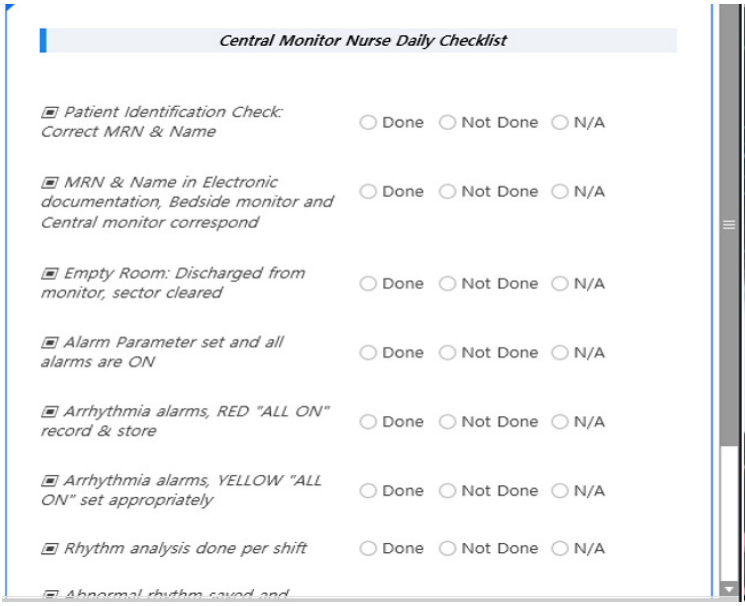

C & E diagram
Process
No appropriate policy
Overuse of telemetry
Machine
No specific profile according to patient population
Majority of yellow alarms inaction able
Device too sensitive
ALARM FATIGUE
Nurse patient ratio
Inexperienced providers
Open ICU
Mixed population
Various skill levels
Other devices that alarm
People
Environment


Process Map
Title
Phase
Primary Nurse
Alarm on
Respond to alarm
True/false
False
Attend and identify cause (e.g. reset limits)
Resolve
Critical alarms
Not true
Attend and resolve
Team leader
Intervene appropriatly
CRN
Collect data on alarms
Identify the C & E
Staff education
NM
Practice issue intervene
Protocol/guidelines
Improve in alarm management

C&E Metric

2. Rate importance of each output to the nurse →	10	9	8	7						
1. List outputs →	Staff fatigue	Delrium	Red alarms	Device						
3. List inputs ↓		4. Rate the strength of the relationship - the effect of each input on each output ↓								5. Prioritize on total score ↓
Assesment	10	3	10	8						163
Knowledge	5	3	8	5						126
Policy	3	1	8	3						94
patient condition	8	5	5	1						92
Patient acuity	8	1	8	1						80
Patient ratio	8	1	8	1						80
patient population	8	1	5	1						56
Isolation	5	1	5	1						56
										0
										0

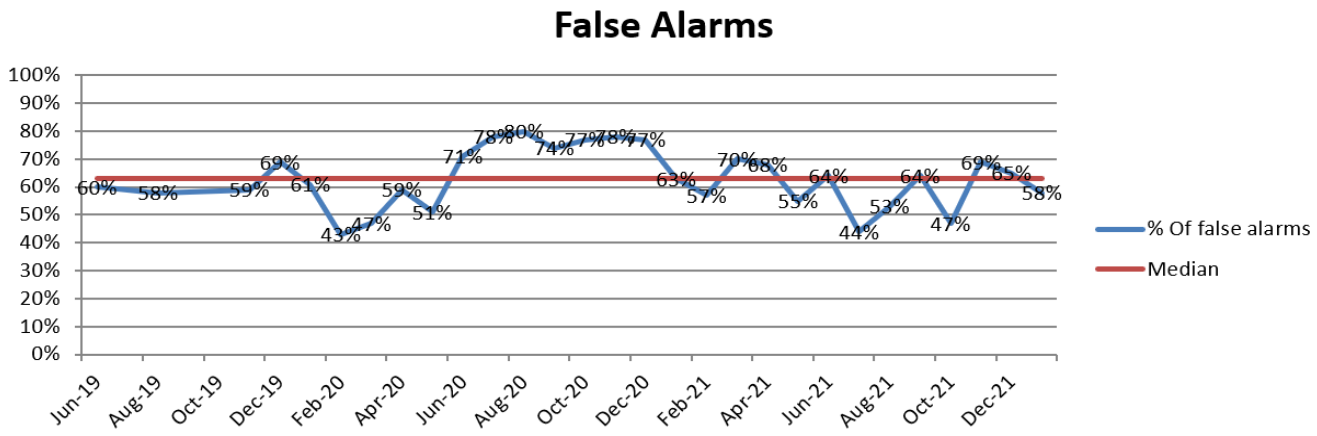
Mitigation



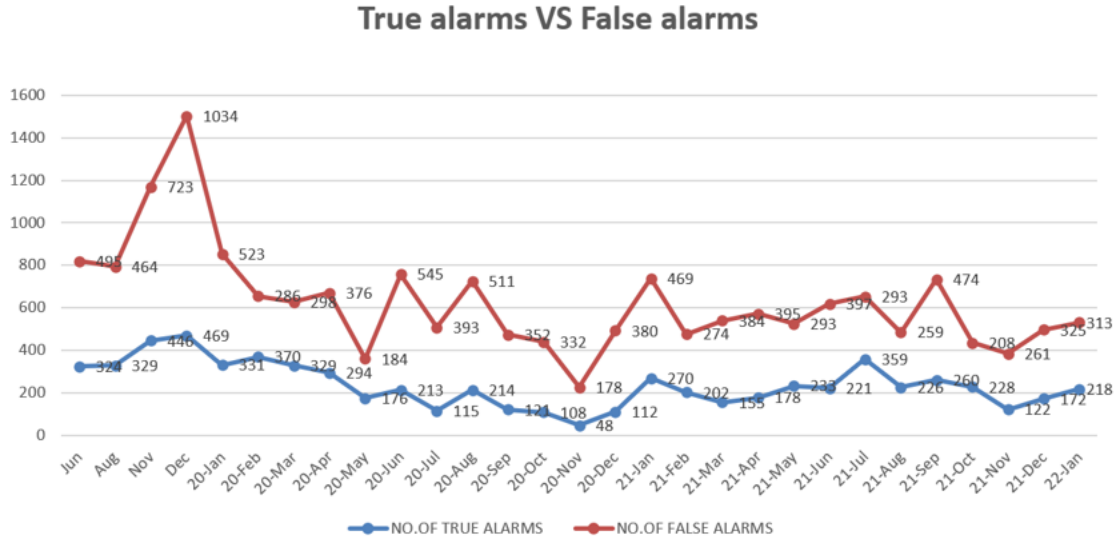
Central Monitor Nurse Daily Checklist

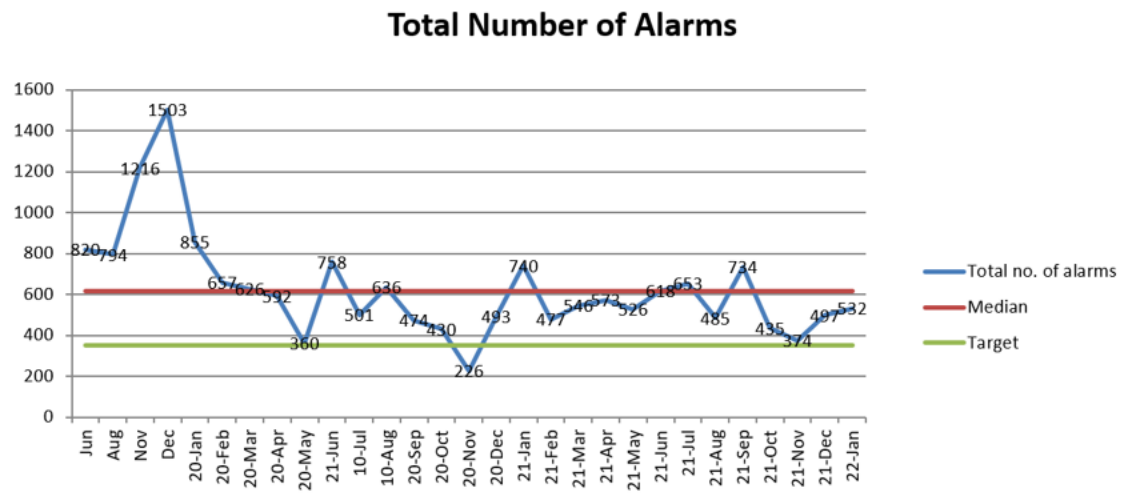
Patient Identification Check: Correct MRN & Name	Done	Not Done	N/A
MRN & Name in Electronic documentation, Bedside monitor and Central monitor correspond	Done	Not Done	N/A
Empty Room: Discharged from monitor, sector cleared	Done	Not Done	N/A
Alarm Parameter set and all alarms are ON	Done	Not Done	N/A
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
Abnormal rhythm saved and			

Month to Month Data



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

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

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 work place should not go beyond 85 dB [5].

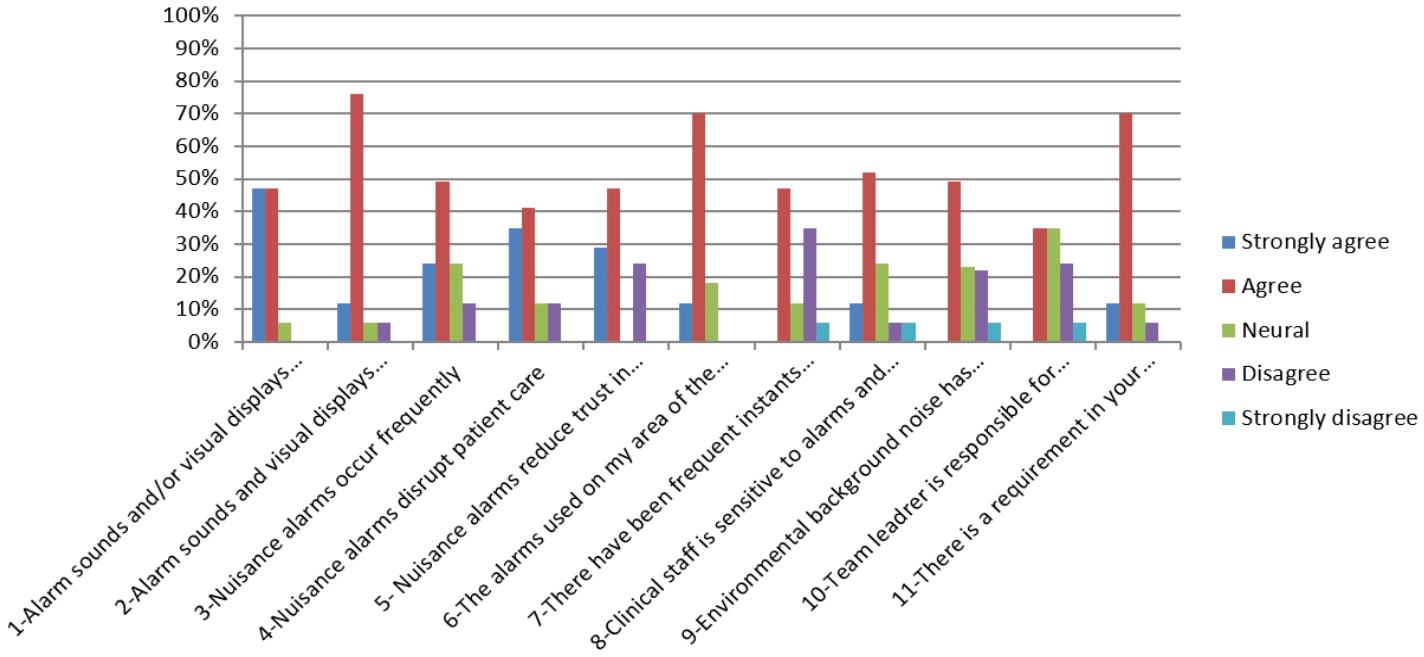
IABFH-ICU Setting

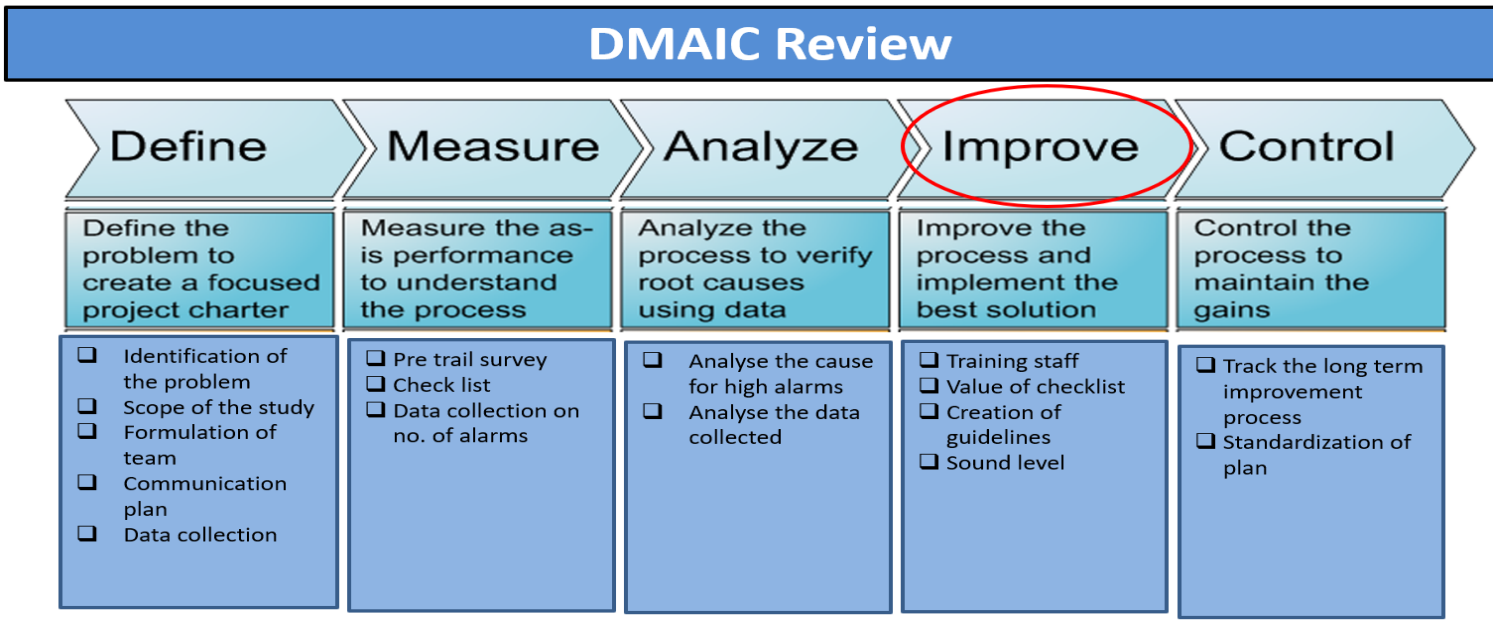
•At the bed side:73.6dB

•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





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

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