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Research Article

Calm The Alarm (A path forward for Safe Alarm Management of Biomedical Equipment)

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ABSTRACT

Biomedical equipment's like infusion pumps, cardiac monitors, ventilators, syringe pumps and feeding pumps etc. are designed to generate alarm signals to indicate any unacceptable physiological patient conditions, unsatisfactory functional states of biomedical equipment or medical electrical systems, or to warn any operator threats. These are the alarms that are all too familiar to nurses & doctors, especially in the intensive care unit, and are all too acquainted with.

Alarm fatigue occurs when 72% to 99% of all alarms are false, according to a study. Alarm fatigue arises when the doctors/nurses are exposed to a large volume of medical device alerts, resulting in alarm **desensitization** and **ignored or delayed alarms**. Alarm fatigue is becoming more widely recognized as a serious patient safety issue as the number of alerts utilized in healthcare increases.

Having those advantages of alarm management also comes with its own challenges in implementation and sustainability(quality). This paper aims to solve those challenges where most of the challenges are identified followed with solutions which are implemented in 700+ bedded hospital and results are compared with earlier to show the effectiveness of the solution proposed by the author. The study aims to provide an overview of studies, interventions and initiatives that highlight attempts to manage and improve alarm systems for quality and patient safety in the hospital context through academic literature reviews, clinician interviews, and evaluations of alarm-related standards and various other steps taken to strengthen the alarm management on the biomedical equipment.

The goal of the entire project was to:- **1) About the Patient:-** To improve patient care, safety and reduce risk of adverse events by developing culture of safe alarm management practices. **2) Standardize & Implement:-** Across Hospital **3) Improve Process:-** Establish a process for improvement of alarm policies and configurations. **4) Identification and Mitigation:-** To identify default alarm limits as per patient's clinical conditions and mitigate risks associated with false alarms. **5) Competency:-** To train and orient the staff to operate and manage the alarm system in biomedical equipment. **6) ZERO in Everything:-** Zero consultant/patient complaints, Zero patient harm due to alarm mismanagement, Zero false alarms, Zero alarm fatigue, Zero anxiety among caregivers, Zero sleep deprivation in patient due to alarm.

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INTRODUCTION

The purpose of alarming medical devices is to produce alarm signals "to indicate inadequate physiological patient states, inadequate functional states of medical electrical equipment or medical electrical system or to warn the operator of hazards to the patient or operator due to the medical electrical equipment or medical electrical system". Ironically, it has been claimed that medical gadget alarms pose a risk to the security of patients. The biggest contributor to the alarm-related adverse effects is due to the large number of alarms ringing in the clinical environment. This leads to desensitization among the caregivers, especially in the critical alarm situations, wherein they don't respond to the clinically critical alarms, thus invoking the patient safety.

Problem Statement is given below:

- 1) Too many alarms lead to alarm fatigue among users thus, leading to silencing of the alarms more often with no intervention. Hence, desensitization for alarm management and inability to differentiate between various biomedical equipment alarms simultaneously takes place.
- 2) Risk of a missed or mismanaged actionable, relevant clinical alarms due to too many alarms ringing or any other factor can lead to patient's clinical deterioration and other adverse effect, thus jeopardizing the patient safety and lower productivity.
- 3) Lack of knowledge and competency of nurses on handling clinical/technical alarm, normal ranges of alarms and its management, wherever required.
- 4) Noise can lead to acute stress for patients and chronic stress for caregivers, with direct physiological and psychological consequences.
- 5) It disrupts the patient's sleep, leading to sleep deprivation and a depressed immune system, thus affecting the recovery and length of stay.
- 6) High levels of non-actionable alarms absorb a significant amount of nurse time, thus compromising a pro-active patient care, with possible impact on quality and patient satisfaction.

7) Consultant complaints due to missed/unattended alarms.

8) Staff lack the competency of alarm management in biomedical equipment, thus leading to silencing of alarms more often with no response and intervention.

A multi-disciplinary team consisting of the Biomedical Department, Nursing and Quality was formed for brainstorming the solutions to these challenges and hence develop Alarm Management as a high risk improvement project. The methodology adopted was PDCA-Plan, Do, Check, Act, Literature Reviews, Brainstorming, Qualitative and Quantitative analysis.

III (a) Goal

1) About the Patient:- To improve patient care, safety and reduce risk of adverse events by developing culture of safe alarm management practices.

2) Standardize & Implement:- Across Hospital

3) Improve Process:- Establish a process for improvement of alarm policies and configurations.

4) Identification and Mitigation:- To identify default alarm limits as per patient's clinical conditions and mitigate risks associated with false alarms.

5) Competency:- To train and orient the staff to operate and manage the alarm system in biomedical equipment.

6) ZERO in Everything:- Zero consultant/patient complaints, Zero patient harm due to alarm mismanagement, Zero false alarms, Zero alarm fatigue, Zero anxiety among caregivers, Zero sleep deprivation in patient due to alarm

III (b) Projected Business Benefits

Clinical alarms are a real and serious problem in all areas of the hospital. An effective alarm management program improves patient care, saves time and money, reduces alarm fatigue, and uses technology to improve the quality of life for the healthcare providers. Decreased alarm fatigue means nurses can more effectively

take care of their patients. After successful implementation of the program, the competency of nurses on clinical alarms will improve, resulting in enhanced patient safety.

Alarm management for biomedical equipment is challenging. However, this project has benefitted the quality of patient care by ensuring prompt interventions and correct actions by the healthcare providers.

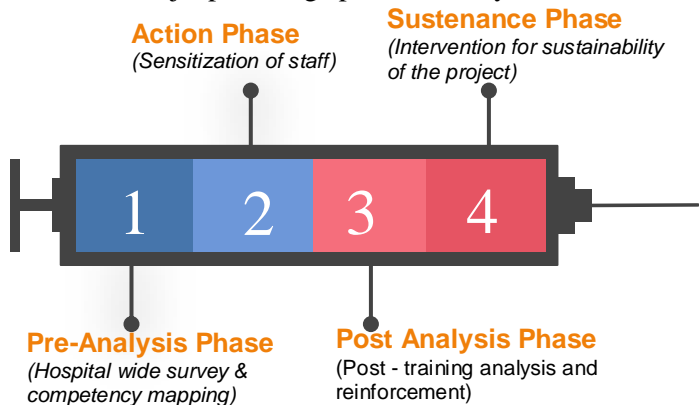
Effective alarm management led to a reduced risk of a missed or mismanaged actionable, relevant clinical alarms due to too many alarms ringing or any other factor could lead to a patient’s clinical deterioration or other adverse effect, thus jeopardizing patient safety and

lowering productivity. Unit study every month led to the identification of issues and opportunities that could possibly reduce the number of false alarms, etc.

Long term benefits include clinical as well as service excellence that would be enhanced and strengthened by this pragmatic approach wherein minimizing false, nuisance alarms is targeted, leading to more accurate, timely, prompt, and enhanced quality of patient care.

IV. MATERIALS AND METHODS

Action Plan:- The Calm the Alarm project was initiated in four phases described below along with the sustenance plan.



Phases	Duration
I	18/06/2022- 25/06/2022
II	10/07/2022- 09/08/2022
III	15/08/2022- 22/08/2022
IV	To be embedded as an ongoing process starting from 01/09/2022

PHASE-1

(Hospital wide survey & competency mapping)

- **1-hour study for 7 days (7 hours/week).**

Unit: -Two ICU’s taken to observe the following: -

- 1) **Unit survey** for the consultant’s & patient’s feedback on clinical alarms (Annexes 9,10).

Note: - Conscious oriented/ Spontaneous patient’s feedback to be considered only.

- 2) Total no. of alarms, equipment wise bifurcation of alarms and the number of alarms per bed (Annexure 1).

- 3) Total number of false/nuisance alarms, how frequent the nurses are silencing the alarm with no corrective action, if applicable, any (Annexure 1).

UNIT AUDIT CHECKLIST							
Date						Custodian Name	
Dept.						Custodian Clock No.	
S.No	Assessment Date	Equipment Name (Ventilator, Infusion Pump, Patient Monitor etc...)	Alarm Color (Red/Yellow/Green/Blue)	Type of Alarm (False/Nuisance/True/Technical)	Alarm Description	Silenced Alarm (Yes/No)	Action taken to manage the alarm

Annexure 2- Unit Audit Checklist Summary										
Note: 1 Hour Study for Observation on Clinical Alarms-MICU & GLMICU										
Duration: 1 Hour										
Se. No.	Summary	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul	09-Jul	10-Jul	11-Jul	Total
		Number	Number	Number	Number	Number	Number	Number	Number	
1	Total number of alarms	56	48	51	43	33	33	8	12	284
2	Number of ventilator alarms	12	10	9	4	7	6	0	2	50
3	Number of hemodynamic alarms	19	30	23	26	15	14	7	2	136
4	Percentage of alarms that came from the violations in heart rate	7	2	5	10	5	6	3	2	40
5	Percentage of Alarms from SPO2	3	3	3	2	2	1	0	3	17
6	Number of Nuisance Alarms	13	22	8	13	7	5	0	0	68
7	Number of False Alarms	9	9	23	13	13	13	5	2	87

Sr No.	Cumulative Summary (For both GLMICU & MICU)	Result
1	Total number of alarms in 1 ICU per day	35.5
2	Number of ventilator alarms per day (Average)	6.25
3	Number of hemodynamic alarms per day (Average)	17
4	Percentage of alarms that came from the violations in heart rate	14.08%
5	Percentage of Alarms from SPO2	5.98%
6	Number of Nuisance Alarms	68
7	Number of False Alarms	87

Annexure 1:- Unit Pre-Analysis on Alarm Management

- **Survey conducted** for nurses on alarm management along with their feedback/suggestions for improvement (Annexure 11).
- Preparation of Standard Operating Procedure (SOP) for Patient Clinical Alarms Safety.
- Preparation of Alarm matrix of biomedical equipment and circulated among all the users (Annexure 2).

INVENTORY OF MEDICAL EQUIPMENT ALARMS								
S.N.	Type of Equipment	What are the clinically appropriate settings for the alarm signals?	Who has the authority to set default alarm parameters?	When should alarm parameters be changed?	Who can Acknowledge the alarm parameter	Who has the authority to change alarm parameters?	When should alarm parameters be disabled?	Training
1	Infusion Pump	1.No Operation 2.Infusion Ending 3.Occlusion 4.Door open 5.Air in line 6.Time out range	Manufacturer	On no occasion	Assigned Staff Duty team leader Duty Doctor	None	At no time.	ER ICU OT Ward Daycare
2	Syringe pump	1.Syringe plunger indication 2.occlusion 3.Syringe detector sensor 4.Near empty 5.Empty	Manufacturer	On no occasion	Assigned Staff Duty team leader Duty Doctor	None	At no time.	ER ICU OT Ward Daycare
3	Patient Warmer	1.Low temp 2.High temp 3.Disconnect alarm 4.No Air flow 5.Weak air Flow	Manufacturer	On no occasion	Assigned Staff Duty team leader Duty Doctor	None	At no time.	OT ICU
4	Patient monitor	1.NIBP Cuff loose 2.Cuff time out 3.Etco2 low or high 4.Check sample line 5.Check Water trap 6.ECG leads off 7.NIBP air leakage 8.SPO2 Probe off 9.Spo2 faulty probe 10.Temperature error 11.Arrhythmia alarm 12.Heart rate low or high 13.BP high or low	Manufacturer	As per patient condition only when there is , EtCO2 high /low, arrhythmia alarm, Heart rate low or high & BP high or low	Assigned Staff Duty team leader Duty Doctor	Anaesthetist / Intensivist	At no time.	ER ICU OT Ward Daycare
5	Ventilator	1.Tidal volume high or low 2.FIO2 low or high 3.Air supply low or high 4.Apnea 5.Circuit Leak 6.ETCO2 high or low 7.Experatory FLOW sensor error 8.Patient connection leak 9.Patient disconnected 10.PEEP high or low 11.Relief valve open	Manufacturer	As per patient condition only when there is Tidal volume high/low, circuit leak, EtCO2 high /low, PEEP high/low	Assigned Staff Duty team leader Duty Doctor	Anaesthetist / Intensivist	At no time.	OT ICU ER

Annexure 2:- Glimpse of Alarm Management Matrix

PHASE-2 for 1 Month (Sensitization of staff)

- **Master Training Class** conducted twice for all the nursing process owners/custodians across a Group of Hospitals by the Nursing Biomedical Engineer along with Post Test.

- **Train the Trainers**-Pretest, trainings and post test conducted followed by their competency mapping. Retraining's done till they are compliant.
- Sensitization of nurses on alarm management along with competency mapping (Annexure 3) post training.

Annexure 5

Clinical Alarms
Competency Checklist

Date: 23/1/22
Name: Helani

Clock No: 026961
Ward/Specialty: 2716

S.No	Proficiency Check	1	2									
1	<p>Is knowledgeable about colour coding of alarms as per the equipment?</p> <p>Reference table for assessment: -</p> <table border="1"> <tr> <td>Red alarm</td> <td>High priority</td> <td>Immediately attend and take action accordingly.</td> </tr> <tr> <td>Yellow alarm</td> <td>Medium priority</td> <td>Attend at the earliest and take action accordingly.</td> </tr> <tr> <td>Green/Blue alarm</td> <td>Low priority</td> <td>Acknowledge, do not ignore and take action accordingly.</td> </tr> </table>	Red alarm	High priority	Immediately attend and take action accordingly.	Yellow alarm	Medium priority	Attend at the earliest and take action accordingly.	Green/Blue alarm	Low priority	Acknowledge, do not ignore and take action accordingly.	1	2
Red alarm	High priority	Immediately attend and take action accordingly.										
Yellow alarm	Medium priority	Attend at the earliest and take action accordingly.										
Green/Blue alarm	Low priority	Acknowledge, do not ignore and take action accordingly.										
2	<p>Is skilful in acknowledging & resetting of alarms as per the equipment?</p> <p>(Explanation: If there is any alarm coming in the equipment, acknowledge, DO NOT IGNORE and the necessary intervention should be done as per the alarm. The alarm limits can also be changed as per the clinical condition of the patient and doctor's advice).</p>	2	2									
3	<p>Is skilful in setting alarm limits, wherever applicable as per the clinical conditions of the patient as advised by the doctor?</p> <p>Note:- Should know about the normal range(High limit & Low limit) of parameters like SPO2, NIBP,RR,HR, Pressures, Rate, Minute Volume etc like in Monitors and Ventilators respectively!</p>	1	2									
4	<p>Is aware about the activation of the alarm at all the times with an audible volume in all the equipment?</p>	2	2									

5	<p>Is aware about the escalation protocol as per the requirement to the concerned team?</p> <p>Note: -</p> <ul style="list-style-type: none"> For actionable clinical alarms- Escalation to the doctor, charge nurse/team leader with necessary intervention. For technical alarms- Escalation to the Biomedical Department. 	2	2
6	<p>Is skilful in writing clinical alarm details to hand off/ time out wherever applicable?</p> <p>Note:- To enhance patient safety, information about important alarms that require extra vigilance along with the changed alarm limits shall be written and communicated during clinical handoff/time out.</p>	2	2
7	<p>Is aware about the escalation & reporting protocol as per the policy in case of any sentinel/near miss events arising due to patient monitoring/ clinical equipment alarm failure?</p> <p>Note: - In case of any abovementioned situations, the same shall be reported to the Charge Nurse/Team Leader, Head of Nursing & Biomedical Department. Incident to be reported in AIRS (Apollo Incident Reporting System).</p>	2	2
8	<p>Is aware about the unexplained nuisance/false alarms to be reported to Biomedical Department/Medical Team with the necessary intervention?</p> <p>Example of Nuisance alarm- An arterial catheter low pressure alarm that activates when blood pressure cuff is inflated. Example of False alarm- No/distorted ECG rhythm due to the patient movement/ECG lead disconnection.</p>	1	2
9	<p>Is knowledgeable about purpose and proper operation of alarm systems for which they are responsible?</p> <p>Note: - At no time should the biomedical equipment alarms be disabled and should have functional alarms.</p>	1	2
10	<p>Is aware about the identification of high risk alarms and their management?</p> <p>Note:- Every nurse should be able to identify actionable alarms (clinical deterioration of the patient), high risk alarms like "High Inspiratory Pressure", "Low FIO2" in ventilators etc.</p>	1	1

Handwritten signature and date: 23/1/22

Band Score:
1-Needs Training
2-Independent

Annexure 3:- Competency Mapping of Nurses on Alarm Management

- External Trainings organized (by the Company Engineer & Doctor) on the biomedical equipment and their alarm management.
- Awards and accolades given for best managers of clinical alarm management as per the audit check tool (Annexure 4).

Audit checklist						
S.no.	Unit	Noise level due to biomedical equipment	Competency Mapping of entire staff & their documentation	Knowledge check of staff	Alarm limits set as per clinical conditions of the patient wherever required.	Overall unit compliance

Annexure 4:- Audit tool to assess the best clinical alarm managers-Unit & Staff

PHASE-3

(Post Training Analysis & Reinforcement)

- Same study conducted in the same ICU's as selected in the Pre-analysis phase to study

patient & consultant feedback (Annexes 9,10) post implementation and to study about the alarm management practices & protocols being followed in the unit (Annexure 5).

Annexure 2- Unit Audit Checklist Summary									
Note: 1 Hour Study for Observation on Clinical Alarms-MICU									
Duration: 1 Hour									
Se. No.	Summary	22-Aug Number	23-Aug Number	24-Aug Number	25-Aug Number	26-Aug Number	27-Aug Number	28-Aug Number	Total
1	Total number of alarms	12	12	36	16	16	6	14	112
2	Number of ventilator alarms	3	3	9	4	4	0	1	24
3	Number of hemodynamic alarms	9	9	27	12	12	2	11	82
4	Percentage of alarms that came from the violations in heart rate	6	3	9	4	4	2	2	30
5	Percentage of Alarms from SPO2	3	1	2	0	0	0	4	10
6	Number of Nuisance Alarms	3	3	9	6	4	0	1	26
7	Number of False Alarms	6	6	18	7	8	2	10	57

Annexure 2- Unit Audit Checklist Summary									
Note: 1 Hour Study for Observation on Clinical Alarms-GLMICU									
Duration: 1 Hour									
Se. No.	Summary	16-Aug Number	17-Aug Number	18-Aug Number	19-Aug Number	20-Aug Number	21-Aug Number	22-Aug Number	Total
1	Total number of alarms	8	8	8	8	8	8	8	56
2	Number of ventilator alarms	4	3	2	3	1	2	2	17
3	Number of hemodynamic alarms	0	1	1	2	3	2	1	10
4	Percentage of alarms that came from the violations in heart rate	0	0	1	1	2	2	0	6
5	Percentage of Alarms from SPO2	0	1	0	1	1	0	1	4
6	Number of Nuisance Alarms	0	0	0	0	0	0	0	0
7	Number of False Alarms	1	1	3	2	1	3	1	12

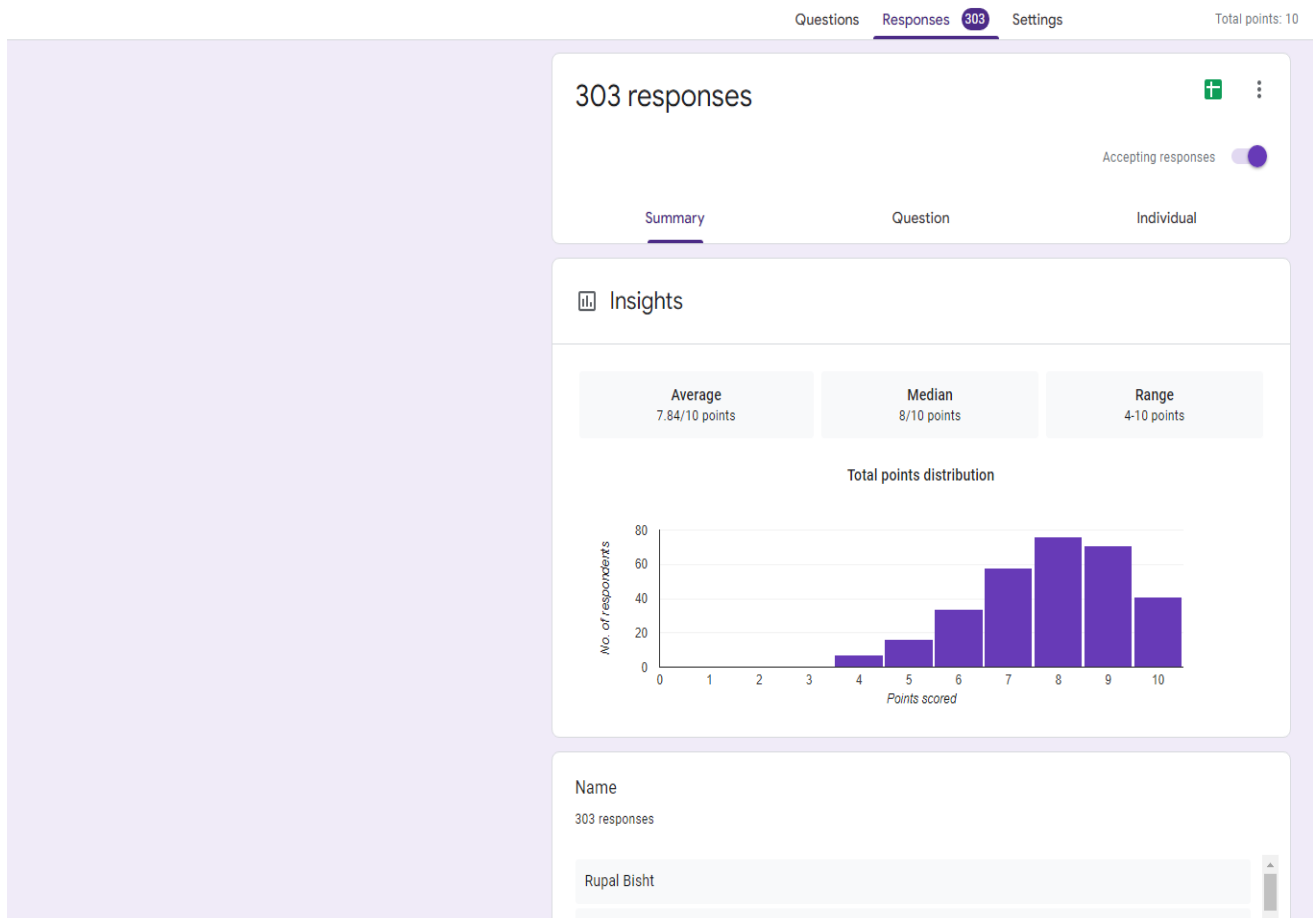
Sr No.	Summary	Values
1	Total number of alarms in 1 ICU per day	24
2	Number of ventilator alarms per day (Average)	5.85
3	Number of hemodynamic alarms per day (Average)	13.14
4	Percentage of alarms that came from the violations in heart rate	21.42%
5	Percentage of Alarms from SPO2	8.33%
6	Number of Nuisance Alarms	26
7	Number of False Alarms	69

Annexure 5:- Unit Post-Analysis on Alarm Management

ACTIVITIES
(To Continue Reinforcement)

- Post analysis quiz(Annexure 6) via Google form for the nurses to assess the knowledge and competency on alarms due to biomedical equipment.

POST ANALYSIS QUIZ ON ALARM MANAGEMENT



Annexure 6:- Post Analysis Quiz on Alarm Management

Annexure 8:- Impact of Clinical Alarm Safety Checklist

The Impact of the Clinical Alarm Safety Program shall be monitored with respect to the following aspects:

- Total number of alarms in one ICU per day - _____
(can be studied any 7 days a month for 1-hour , i.e. 7 hours/month/ICU)
- Number of ventilator alarms per day (average) - _____
(can be studied any 7 days a month for 1-hour , i.e. 7 hours/month/ICU)
- Hemodynamic alarms per day (average) - _____
(can be studied any 7 days a month for 1-hour , i.e. 7 hours/month/ICU)
- % of the alarms from the violations in heart rate default settings - _____
(can be studied any 7 days a month for 1-hour , i.e. 7 hours/month/ICU)
- % of alarms from SpO2 - _____
(can be studied any 7 days a month for 1-hour , i.e. 7 hours/month/ICU)
- Number of Patient complaints due to noise caused by biomedical equipment- _____
- Total number of Consultant complaints due to noisy wards and ICUs - _____
- Total number of staffs trained on Clinical Alarm Management & Safety – _____
- Reduction in Nuisance alarms- _____
- Reduction in False alarms - _____
- Any other can be added up as per the unit requirement.

Cost of Implementation- Rs. 1800/- for the prize distribution, gifts & accolades.

Challenges faced during implementation-

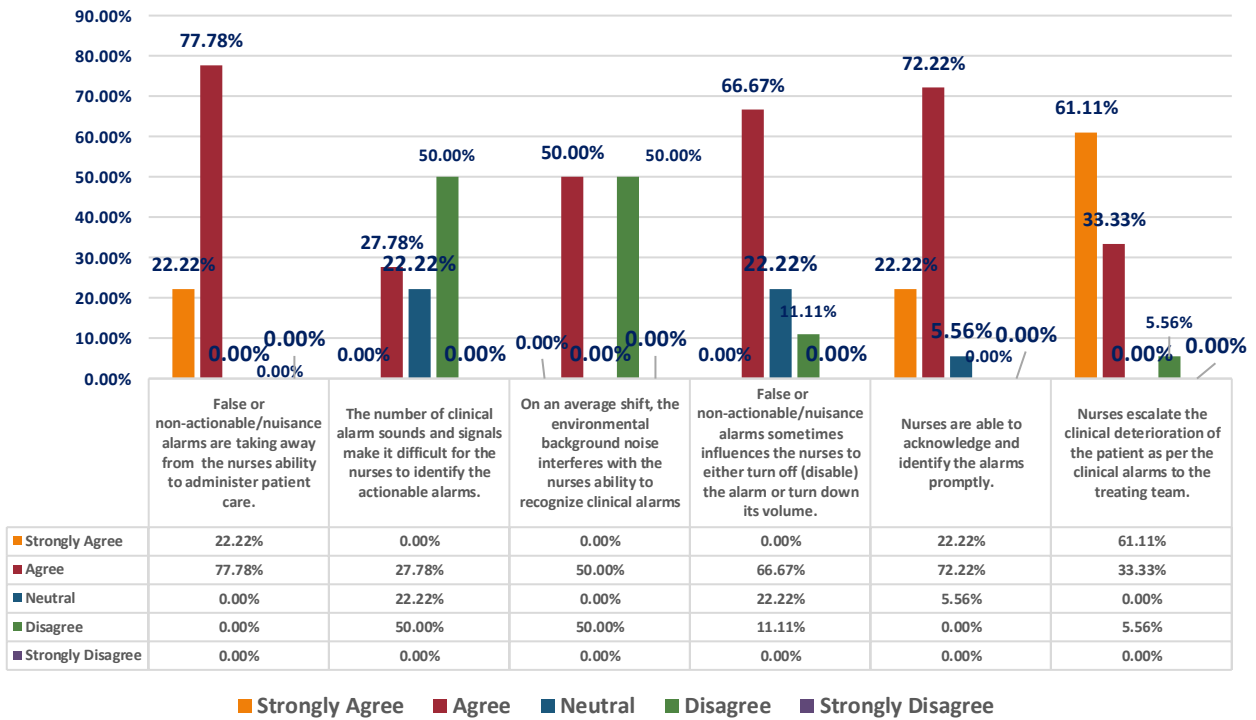
There are still some challenges because of the high attrition rate, huge alarm inventory, different models of equipment, staff competency in True, False & Nuisance alarms differentiation, response time based on priority and action to be taken, thus, regular training on alarm management is very important. It has been made a monthly ongoing process so that all our new and existing staff are in compliance with the new JCI standards and protocol also do not jeopardize the quality of patient care or safety due to mismanagement of alarms. Regular meetings are also done with all the stakeholders to discuss any issues related to the

mismanagement of alarms, implementation, compliance, enhanced coordination and to look for any scope of improvement, if any. Random audits along with the unit analysis to monitor the process continuously are done to ensure compliance, look for scope of improvement and thus strengthen the process.

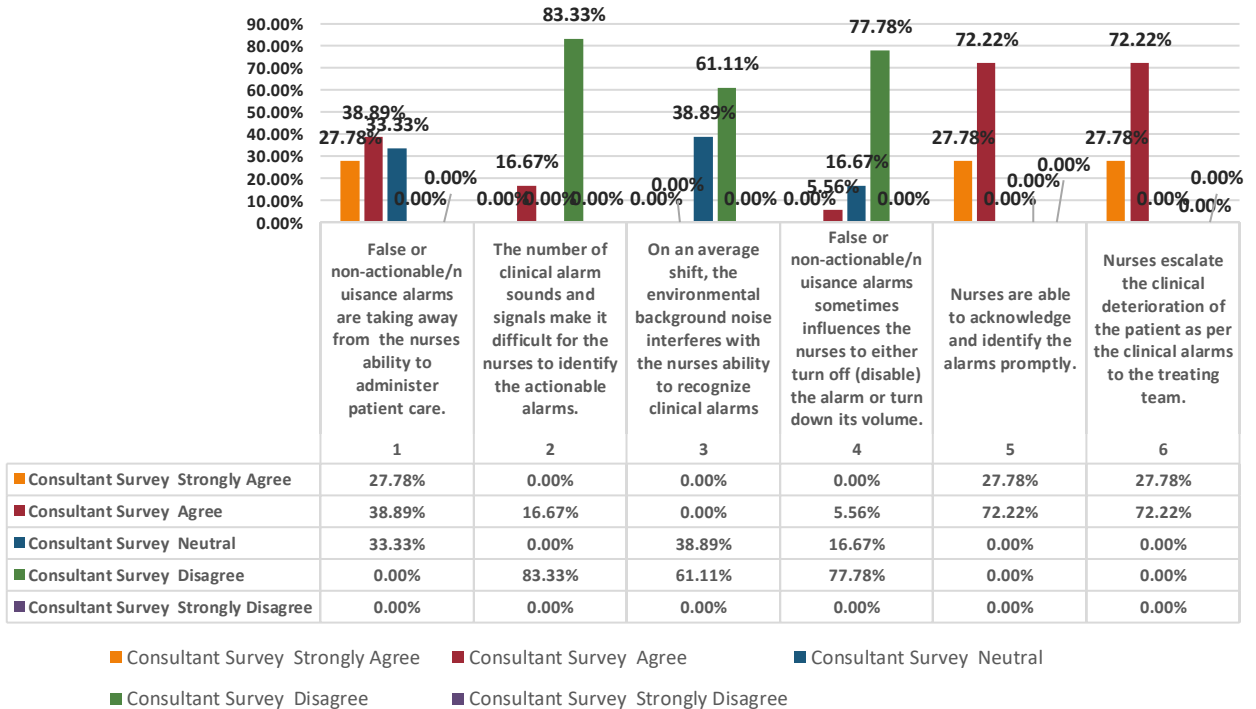
RESULTS

- ❖ The number of False Alarms reduced from **87** to **69** and the number of Nuisance alarms reduced from **68** to **26** (cumulative total for 7 days).
- ❖ Reduction in the total number of alarms from **35.5** to **24** (cumulative for 7 days).
- ❖ Reduction in consultant complaints and improvement in their satisfaction rate (Annexure 9).

Pre-Cumulative analysis of Doctor's Survey

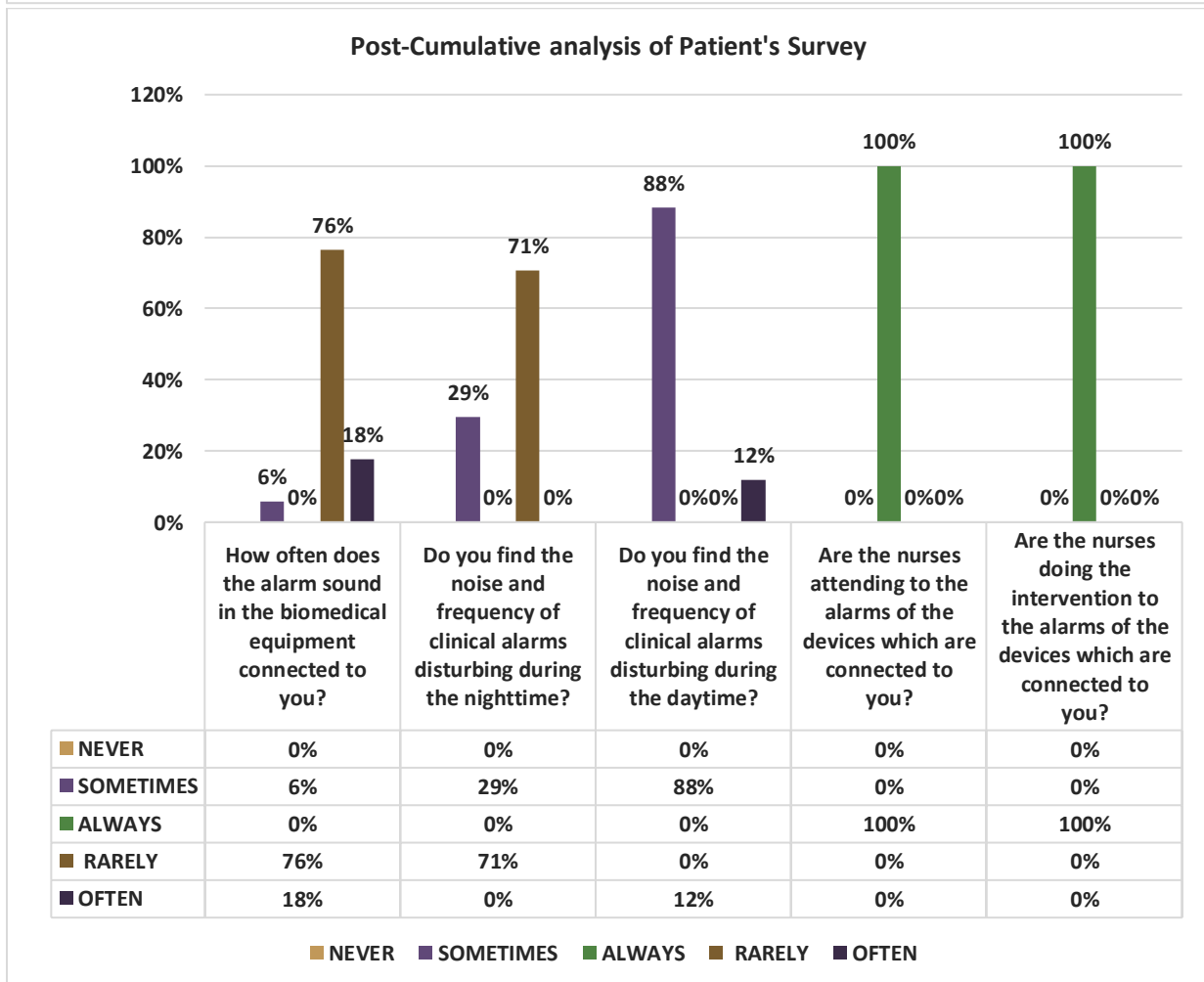
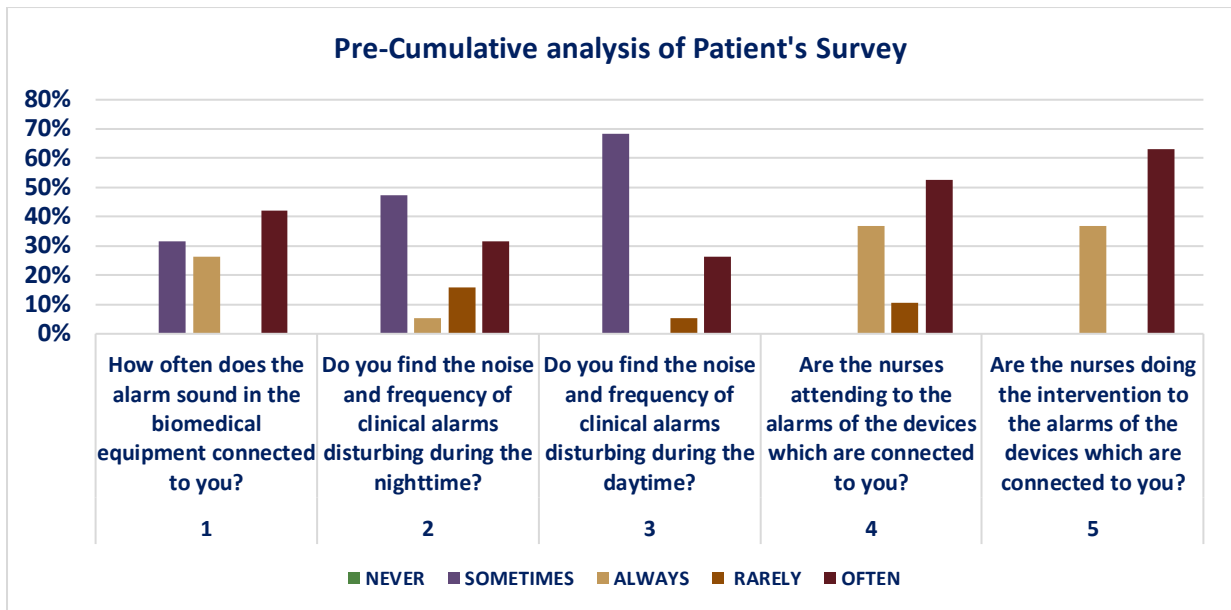


Post-Cumulative analysis of Doctor's Survey



Annexure 9:- Consultant Survey-Pre & Post Analysis

- ❖ Improvement in Patient Satisfaction rate (Annexure 10) in terms to the staff managing the alarms of biomedical equipment.



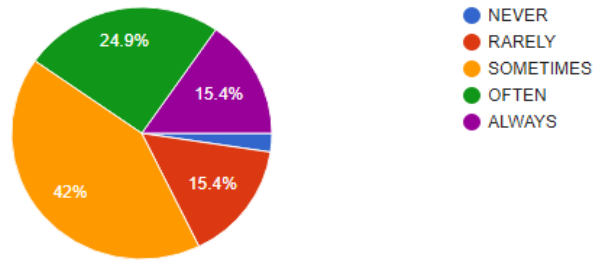
Annexure 10:- Patient Survey-Pre & Post Analysis

❖ In the Pre-analysis phase, the following result was recorded (total no. of participants- 293) via Google form Survey (Annexure 11).

How often does the biomedical equipment alarm in your unit ?



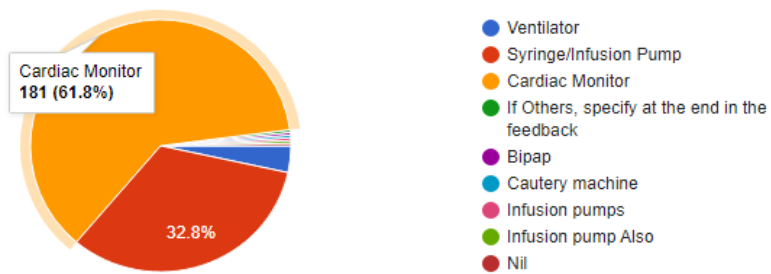
293 responses



Which of the following equipment gives the maximum number of alarms ?

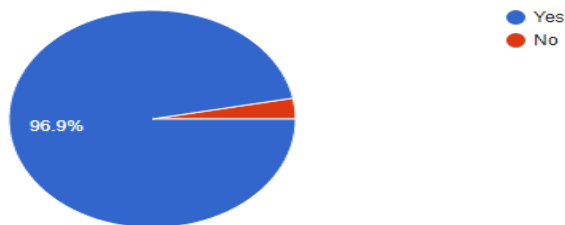


293 responses



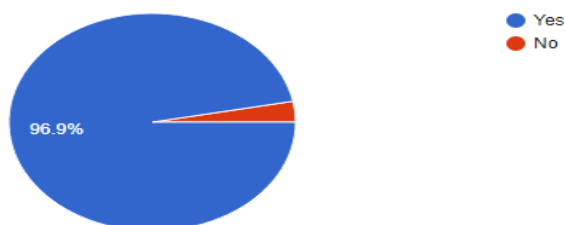
Do you take any action after silencing the alarms?

293 responses



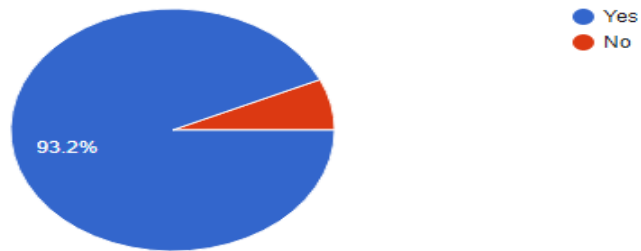
Do you inform the treating team about the patient's clinical deterioration as per the clinical alarm?

293 responses



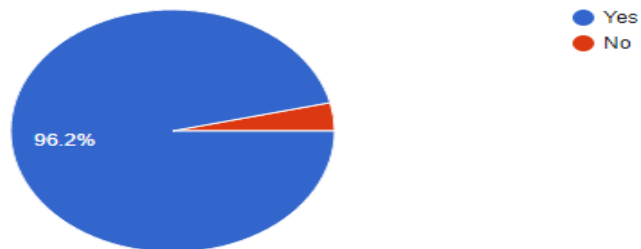
Are you escalating any technical alarm issues to the biomedical team?

293 responses



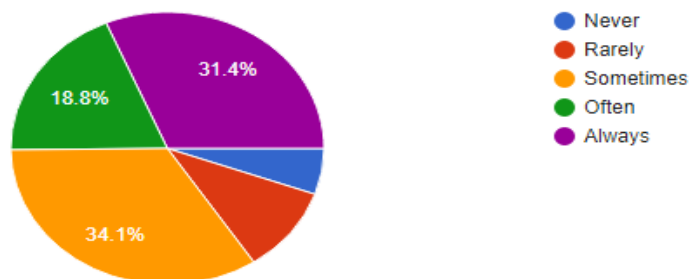
Do you set the alarm limits as per the patient's clinical condition?

293 responses



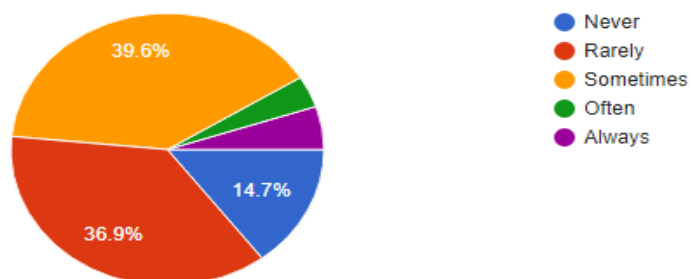
How frequently have you attended the training on Alarm Management?

293 responses



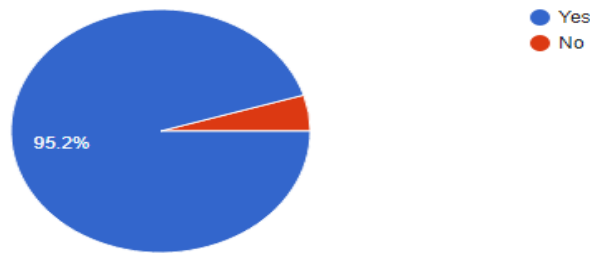
How often have the doctors complained about the clinical alarm?

293 responses



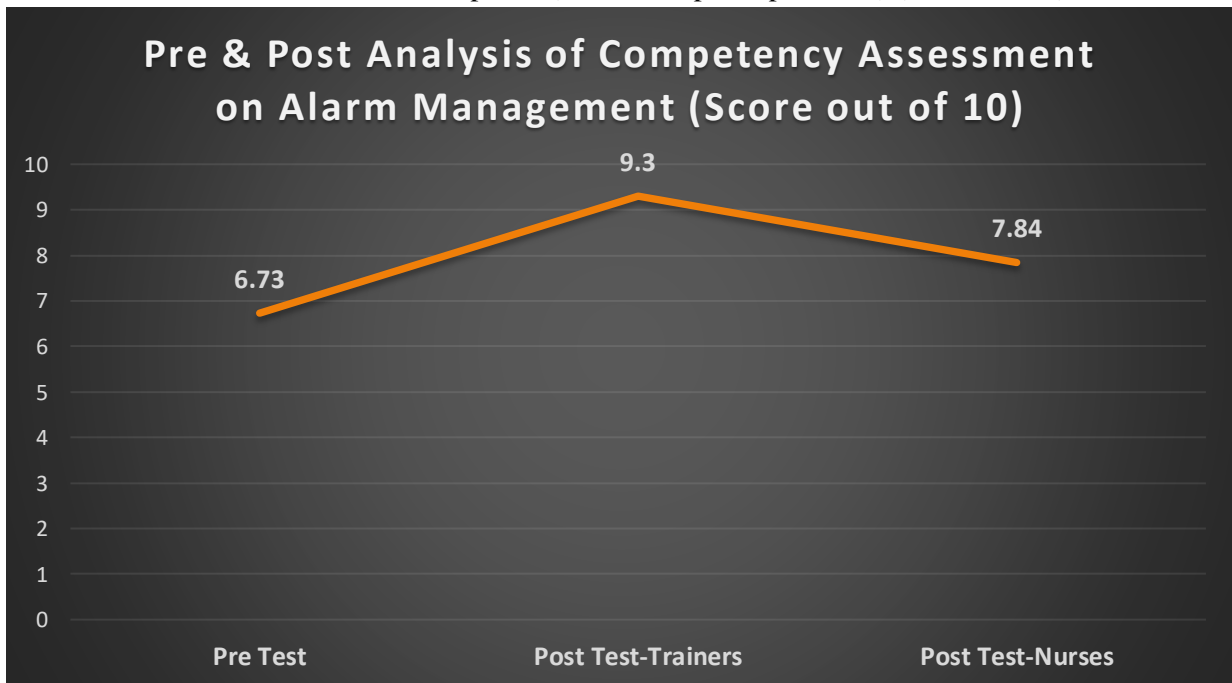
Are all the biomedical equipment enabled/activated at an audible volume?

293 responses



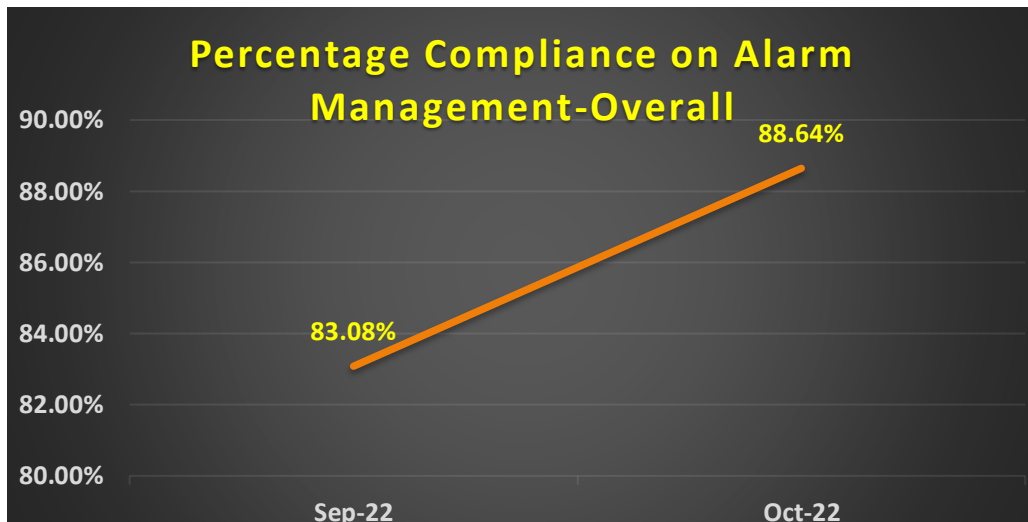
Annexure 11:- Pre-Analysis Nurses Survey

- ❖ In the Pre-test conducted for all the trainers, the average score achieved was 6.73 out of 10 points and in the Post-test it was 9.30 out of 10 points (total no. of participants- 49) (Annexure 12).



Annexure 12:- Pre & Post Analysis of competency assessment on Alarm Management for Trainers & Staff Nurses

- ❖ **In the competency mapping of trainers after the effective training, all were found competent (Total no. of participants- 49).**
- ❖ **Competency mapping was done for all the trainers along with the nurses-100% covered (Total participants- 1000+).**
- ❖ **In the hospital wide Post-test for nurses, improvement in the skills and competency of staff on alarm management was seen; the average score was 7.84 out of 10 points (Total no. of participants- 303) (Annexure 12).**
- ❖ **The knowledge check was done for the senior level staff across a group of hospitals on alarm management after the effective training and the average score was found to be 9.63 out of 12 points (Total no. of participants- 87).**
- ❖ **During the audits as per the Alarm Management Tracker starting in September 2022, the percentage compliance was 83.08% in September, 88.64% in October (Annexure 13).**



Annexure 13:- Percentage compliance on Alarm Management

Other units can also adopt this project in a systematic and phased manner, thus leading to better management of clinical true actionable alarms, reduce false & nuisance alarms, enhance staff knowledge and awareness on alarm management, thus leading to improved quality of patient care.

DISCUSSION

Clinical alarms are a real and serious problem in all areas of the hospital. An effective alarm management program improves patient care, saves time and money, reduces alarm fatigue, and uses technology to improve the quality of life for the healthcare providers. Decreased alarm fatigue means nurses can more effectively take care of their patients. After successful implementation of the program, the competency of nurses on clinical alarms will improve, resulting in enhanced patient safety.

Alarm management for biomedical equipment is challenging. However, this project has benefitted the quality of patient care by ensuring prompt interventions and correct actions by the healthcare providers.

Staff awareness of alarm management was enhanced, leading to better quality patient care.

Quality of patient care and alarm management of biomedical equipment led to sensitization for alarm management and an enhanced ability to

differentiate between various biomedical equipment alarms that take place simultaneously.

Effective alarm management led to a reduced risk of a missed or mismanaged actionable, relevant clinical alarms due to too many alarms ringing or any other factor could lead to a patient's clinical deterioration or other adverse effect, thus jeopardizing patient safety and lowering productivity. Unit study every month led to the identification of issues and opportunities that could possibly reduce the number of false alarms, etc.

Monthly practicum for the existing staff, regular induction training for new joiners, and other in-house and out-house trainings have been incorporated, leading to enhanced knowledge and competency of nurses on handling clinical/technical alarms, normal ranges of alarms and their management, wherever required.

Reduced number of alarms has led to reduced noise that could lead to acute stress for patients and chronic stress for caregivers, with direct physiological and psychological consequences, also disrupting the patient's sleep, leading to sleep deprivation and a depressed immune system, thus effecting the recovery and length of stay. This has led to positive patient & consultant feedback on the alarms ringing in the units.

Non-actionable alarms (False & Nuisance) have reduced leading to a significant amount of nurse time spent in a proactive patient care, with a possible impact on quality and patient satisfaction.

Consultant visits and complaints due to missed/unattended alarms have also decreased, leading to better quality of patient care. Patient's feedback also turned positive after effective implementation of alarm management protocols. It has also become an ongoing process, leading to continuous monitoring of the loopholes, issues related to alarm mismanagement that can harm the patient.

The Alarm Management has a oversight of many custodians -Quality, Nursing, Biomedical Department , Biomedical Engineer (Nursing) along with the Charge Nurses of the respective units, thus strengthening the process. Hence, Standard Operating Procedures, Alarm Matrix and continuous training were identified for all the nursing staff so as to enhance & strengthen their competency and knowledge on alarm management of biomedical equipment.

Regular meetings by the concerned stakeholders have led to improved coordination between various departments, better problem solving capabilities and efficient alarm management of biomedical equipment. Unit level study conducted on monthly basis led to better

monitoring, control and execution of alarm management protocols at the ground level, enhancing the quality of patient care. Long term benefits include clinical as well as service excellence that would be enhanced and strengthened by this pragmatic approach wherein minimizing false, nuisance alarms is targeted, leading to more accurate,

CONCLUSION

Clinical alarms are a real and serious problem in all areas of the hospital. An effective alarm management program improves patient care, saves time and money, reduces alarm fatigue, and uses technology to improve the quality of life for the healthcare providers. Decreased alarm fatigue means nurses can more effectively take care of their patients. After successful implementation of the program, the competency of nurses on clinical alarms will be improved, resulting in the enhanced patient safety.

REFERENCE

1. Joint Commission International, 7th edition, Effective from 1st January 2021, Page-114, COP 3.1.
2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6069923/>
3. <https://www.aami.org/docs/default-source/uploadedfiles/filedownloads/foundation/alarms/sun-1000-simoncini.pdf>

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