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Reducing Alarm Fatigue in Critical Care

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Reducing Alarm Fatigue in Critical Care:

Minimizing Alarm Occurrences

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Clinical Leadership Theme

The intention of this project is to improve patient safety on the Critical Care Unit (CCU) of an acute care hospital in northern California. Activities include conduction of a unit gap analysis, micro-system needs assessment, identification of risk factors, and interventions intended to reduce the risk of patient harm related to alarm fatigue and alarm mismanagement.

Throughout the process of this project experience has been obtained in each role of the Clinical Nurse Leader (CNL) as described by the American Association of Colleges of Nursing (AACN). This project is closely aligned with the role of Systems Analyst/ Risk Anticipator, which is to evaluate systems in place, identify risks to patient safety, and use systems level intervention and evidence-based practice to minimize identified risks (AACN, 2013).

Statement of the Problem

Alarm fatigue has been described as the phenomena of alarm desensitization which can lead to delays in treatment and other adverse events including death (Hyman, 2014). The Association for the Advancement of Medical Instrumentation (AAMI) states alarm fatigue is caused by frequent exposure over time to alarms which require no intervention (AAMI, 2015).

The Joint Commission (TJC) impresses that 85-99% of clinical alarms don't require clinical intervention from staff. Acute care hospitals have been found to have hundreds of alarms sounding in patient care areas. Some of these alarms sound similar and are difficult to decipher. These issues contribute to the care provider's learned response of ignoring, disabling, or inappropriately managing patient physiologic alarms (clinical alarms). Thus, rendering the equipment ineffective and putting patients at risk for undo harm (TJC, 2013).

TJC received 98 documented sentinel events between 2009 and 2012 which were directly caused by alarm management or response issues. 80 of these events resulted in death. Top causes have been identified as misuse of alarm parameters, inaudible alarms, and disabled alarms. The most common contributing factors documented are alarm fatigue, alarm parameters not being individualized to the patient, and lack of staff training or education on alarm management. This data resulted in the addition of alarm fatigue reduction to the National Patient Safety Goals for 2014. The guidelines include individualized micro-system assessment, creation of an alarm management policy, staff education/ training, and ongoing evaluation of the effectiveness and safety of the process (TJC, 2013).

Project Overview

This project is designed to improve the standard of care on CCU through implementation of an alarm management policy, staff education, and improved telemetry ordering processes which standardize practices to increase patient safety. The interventions implemented are based on evidence-based practice and will be carried out by all staff working on the unit.

An interdisciplinary committee comprised of management, administration, nursing, biomedical, quality improvement, education, and policy/ procedure personnel was established with the purpose of reducing alarm fatigue and associated patient safety risks. The committee employs consensus and evidence-based practice to design and implement an alarm management policy, unit-based procedures, and patient population specific interventions to reduce risks to patient safety.

A second interdisciplinary team including physicians, department leadership, and educators was created to design, evaluate, and improve the continuous cardiac monitor (telemetry) ordering process. The American Heart Association (AHA) Guidelines for Cardiac Monitoring were implemented to restrict telemetry use to patients who are likely to have treatment initiated or changed based on monitor feedback. The AHA guidelines separate patients that meet criteria into three classes (I-III), which designate initiation and duration of cardiac monitoring based on patient diagnosis and condition (AHA, 2004). Examples of AHA guidelines are provided in Figure 1, Appendix A.

Improvement will be measured by a reduction in alarm occurrences. Measurements will be taken via direct observation to provide empirical data on the amount of alarms sounding per hour on the unit. Supportive evidence is to include improvements in staff perception of alarm fatigue measured by electronic survey and personal interviews, and reduction of inpatient telemetry orders house-wide measured by retrospective chart reviews. Measures are to be collected pre- and post-intervention to clearly illustrate effectiveness of interventions.

Successful execution will conclude in reduction of the total number of alarms sounding on CCU by at least 20% on or before January 1st 2018. This will decrease the stimulus proven to cause the risk of developing alarm fatigue. Alarm fatigue risk reduction increases patient safety by creating the conditions necessary for clinical staff to hear, identify, and appropriately respond to clinical alarms.

Rationale

Unit gap analysis data revealed the absence of practice guidelines and documentation required by TJC. Further assessment of the facility confirmed no standardized alarm management procedures, specific alarm related event documentation, alarm management policies, or alarm management education existed house-wide. Personal interviews and staff surveys reinforced the need for educational intervention as well as standardized alarm management processes.

Retrospective chart reviews illustrate over 30% of in-house continuous cardiac monitor orders fell outside of evidence-based AHA guidelines. CCU is home to the hospital’s central monitoring station and is responsible for 72% of alarm occurrences. This data indicates that an improvement in the ordering process could potentially decrease the overall number of clinical alarm incidents per hour by nearly 22%.

Direct observation data gathered during one to two-hour sessions taken on different days and at different times show 97% of alarms sounding on CCU require no intervention outside of silencing the alarm or trouble-shooting equipment. A total of 1,696 alarms were observed over 16 hours with an average hourly rate of 106 occurrences. This means that there is an average of 103 non-actionable alarms sounding hourly on CCU. Each occurrence identified was evaluated for source, duration, and need for intervention. The most frequently documented alarms came from central cardiac monitors, followed by IV pumps, bedside monitors, and bed alarms. Observation results are listed on Table 1, Appendix B.

Efforts to assess staff perceptions of alarm fatigue were carried out by electronic survey and personal interviews. Seven questions were asked of all clinical staff working in the facility prior to project intervention and repeated post intervention. Answer options included yes/ always, maybe/ sometimes, and no/ never. To divide answer values into positive and negative results, maybe/ sometimes answers were grouped with affirmative values. Results from 797 participants show 46% of clinical staff who took the survey feel that emergent alarms are difficult to distinguish, 25.9% don't know how to properly set alarm parameters, 81.7% feel that alarms on the unit usually do not require an intervention, and 67.2% say that alarms frequently sound for extended periods of time. Survey results can be found in figures 2 and 3, Appendix C.

Retrospective chart reviews of 102 patients were conducted to evaluate telemetry utilization house-wide. Chart review was not limited to the unit because CCU houses the hospital's central monitor. Criteria for review included continuous cardiac monitoring order, and admission date in the month of November, 2016. Patients placed in beds which include continuous cardiac monitoring in the standard of care were excluded. Data collection of patient initials, age, medical record number, primary diagnosis, date and time of initial order, date and time of discontinuation of order, date and time of discharge, discontinuation prior to discharge, number of days on monitor, ordering provider, and whether AHA guideline criteria for continuous cardiac monitoring was met. Additional relevant comments were also documented such as lab values, procedures, and patient condition changes.

Results impressed that 31% of orders did not meet AHA criteria, 78% of orders which fell outside of criteria were ordered by hospitalist providers, and only 1% of patients experienced an arrhythmia that was caught and treated based on monitor data. This indicate the need for education and implementation of a process for evaluating the need for cardiac monitoring.

The review data shows the average days on telemetry at 2.47 house-wide, and 3.48 for Medical-Surgical level patients. Only 19% of orders were discontinued prior to discharge. This indicates that the need for continued monitoring is not being addressed daily. General analysis of all in-house admissions indicates 56.2% of patients in the month of November, 2016 received continuous cardiac monitoring orders. Chart review results can be found in figures 4 – 9, Appendix D.

Financial analysis was based largely on cost savings related to eliminating risk of at least one alarm-related adverse event (with legal fees) per year, and avoiding unnecessary staffing ratio changes for telemetry patients house-wide. The Physician-Patient Alliance for Health and Safety estimated that each adverse event that is taken to litigation costs hospitals an average of $118,750 (Power, 2013).

Medical-Surgical level patients with telemetry orders must be staffed at a nursing ratio of 1:4 as opposed to the standard 1:5. Over 43% of total continuous cardiac monitor orders during the review period were placed on patients who required this staffing ratio change. Considering the average RN wage of $55 per hour in-house (excluding benefits and over-time), this costs the facility an extra $660 per 12-hour shift for up to four telemetry patients. This also means, every fifth patient placed on telemetry in one of these beds increases staffing costs by $1,320 daily. With an average monitoring duration of 3.48 days, every fifth patient in this group increased staffing costs by an average of $4,594. This cost the facility $353,760 for all Medical-Surgical level telemetry orders in the month of November, 2016. With the elimination of only this population's telemetry orders which do not meet AHA criteria, the facility could have saved $46,200 for this month alone. Which comes to a staggering $554,400 per year.

The above analysis is based on one RN accepting care of four 1:4 telemetry patients. Depending on the patient population, order of arrival, and staff working, this is not always possible. In this case, further staffing costs will incur. Additional costs include those related to increased lengths of stay for patients who experience undo harm due to alarm fatigue, avoidable law suits, unnecessary use of supplies, time spent tending to monitor equipment, decreased healing time of patients with undo stress from incessant alarms, decrease productivity of staff, and reduction in hospital reimbursement related to inappropriate diagnosis or documentation which doesn't warrant use of telemetry.

The projected cost of the initiation year is expected to be $66,930. This includes one hour of education time and 15 minutes of survey response time for clinical RNs and CNAs house-wide. There will be no additional cost for current salary employees and no cost for the CNL patient care management service which was conducted through student hours. Reduction of

Medical-Surgical level telemetry orders which do not meet criteria and avoidance of one adverse event with litigation during the start-up year, projects a savings of $673,150, creating a net benefit of $606,220.

The second-year cost of the project is estimated at $173,300. Which includes an annual one hour education update for clinical RNs and CNAs house-wide and one year's salary for one CNL. With continual evaluation and improvement of interventions through employment of the CNL, the second-year savings will include a 20% reduction in telemetry use from baseline data and avoidance of one adverse event with litigation. Thus, the net savings for year two is predicted to be $499,850. Financial data can be found in Table 2.

Methodology

Lewin's Change Theory was utilized to strategically plan implementation of the interventions previously described. The process is composed of three stages; Unfreezing, Moving or Changing, and Refreezing. During the first stage, the belief system which is the baseline of knowledge and behaviors to be changed is challenged. The second stage incorporates the new belief system desired for sustaining change, and the third solidifies the new knowledge and behaviors as part of the culture (Schein, 1996).

For this project, the Unfreezing stage brought awareness of the importance and degree of the problem to stakeholders through surveys and education. The moving stage was marked by creation and introduction of the new alarm management policy and process for implementing AHA guidelines. The final stage of Refreezing entails setting the 'go-live' date for the interventions and continued follow-up on the compliance of the process. This part of the plan also includes continued evaluation of the effectiveness of the new processes.

Educational goals to disseminate details of each intervention were reached through assignment of a one-hour education module. Objectives of 90% of clinical staff to complete the electronic module and the post-test with 100% accuracy by March 27th, 2017. Achievement of this goal was evaluated through use of the internal education system.

Intervention objectives were to reduce telemetry orders house-wide by 20% and reduce occurrences of clinical alarms on CCU by 20% by January 1st, 2018. Evaluation of the achievement of these goals will be carried out through post-intervention retrospective chart reviews and direct observation data collection. These evaluation techniques will be repeated identically to the pre-intervention evaluations to ensure validity.

Data Source/ Literature Review

Literary reviews were conducted through use of the PICO strategy which guides search criteria selection through identification of the specific problem, intervention, alternative comparison, and desired outcomes. 28 articles were reviewed, after a selective process of practical application to this project and publish dates within the last five years, 10 were chosen to support this purpose. This section provides a brief overview of the top six articles.

The Association for the Advancement of Medical Instrumentation published the *Clinical Alarm Management Compendium* in 2015. This goes over the important points for hospitals to know about TJC National Patient Safety Goals related to Alarm Fatigue, identifies common challenges, and provides suggestions for proper alarm management (AAMI, 2015). The American Association of Critical-Care Nurses provides guidance for unit gap analysis, survey suggestions, TJC policy requirements, and ways to make implementation of alarm management successful (AACN, 2013).

Evidence-based practice in alarm management has been thoroughly researched through 78 articles and summarized by Cvach (2012). It has been shown that proper alarm management includes implementation of processes such as individualizing alarm parameters for specific patient conditions, ensuring bed alarms are only used on appropriate patients, checking equipment prior to usage, and ensuring proper default settings (Cvach, 2012).

The history of events which led to the TJC adoption of this specific National Patient Safety Goal is described by Hyman. A full overview of the guideline requirements is then provided with suggestions on modes of bringing the guidelines into facilities (Hyman, 2014).

Timeline

The purposed timeline spans two years from January 2016 through January 2018. Project activities begin with the unit gap analysis which began at the end of January 2016 and continued through March 2016. Continued needs assessments and evaluations brought further insight to which evidence-based interventions to implement. Personal interviews and staff surveys began in March, 2016 and remained open through December, 2016 to gather as much data as possible. Data collection from chart reviews and direct observation sessions began in May, 2016 and continued through February, 2017. The alarm fatigue committee was developed in July, 2016 and is still assembled today. As is the telemetry utilization committee which started in December, 2016. Staff education modules were assigned for telemetry ordering process changes and alarm fatigue/ alarm management for the month of March, 2017 and both have ‘go-live’ dates in the beginning of April, 2017. Re-evaluations and data collection post intervention will start in October, 2017 with results by January, 2018.

Expected Results

The specific objectives of the project are expected to be met and exceeded. The interventions employed have been well research, planned, and aided by the interdisciplinary team. This means there will be at least 20% less alarms sounding on CCU per hour, and at least 20% less telemetry orders per month house-wide. There is an expected period of adjustment which requires extra support and continued assessment and supplemental education.

Nursing Relevance

The current concepts in healthcare that are being challenged in this effort are that of medical waste, one-size-fits-all approach to patient care, and the habitual use of medical technology to make care providers and patients feel that everything possible is being done even when the technology is incapable of providing any assistance. CNLs are change agents for healthcare facilities which bring challenges such as these to the existing culture to bring improved care process that make care more effective and more efficient. This project meets this expectation and more.

Summary

This project took place on the Critical Care Unit (CCU) of a 298-bed non-profit hospital in Northern California beginning January, 2016. The facility is a Planetree affiliate which leads in providing patient-centered care based on evidence and standards (Planetree, 2016). The unit houses 54 beds and employs over 210 employees including nurses, nursing assistants, unit secretaries, and monitor technicians. The patient population is comprised of adults with diagnoses such as heart conditions, pulmonary diseases, and other conditions which are stable but may become unstable at any time. CCU houses the facility’s central cardiac monitoring station which utilizes unit staff who work with employees all over the hospital to provide this service.

The objective was to improve patient safety through reducing the risk of alarm fatigue by decreasing the total number of clinical alarms on the unit. Specified goals included a 20% reduction in the number of alarms sounding on the unit with a 20% reduction in telemetry utilization. These goals were chosen based on unit assessment findings in comparison to The Joint Commission's (TJC) National Patient Safety Goals and associated guidelines, as well as the American Heart Association's (AHA) guidelines for inpatient continuous cardiac monitoring (TJC, 2014; AHA, 2004).

Stages of the project were implemented using the methods of Lewin's Change Theory, which includes Unfreezing, Movement, and Refreezing (Schein, 1996). The Unfreezing stage was conducted through dissemination of information regarding evidence-based practice, and staff surveys/ interviews to assess and challenge the current belief system regarding alarm management. The Movement phase was marked by the go-live date of the Management and Response to Clinical Alarms policy, and the new telemetry order process. The final stage of Refreezing was begun by conducting daily audits of the telemetry order process, monitoring alarm related event documentation, and providing real-time feedback and supplemental education to staff on a case-by-case basis.

Evaluation of effectiveness was completed through daily audits of telemetry usage totals in comparison to census (Appendix K), post-intervention direct observation data collection on alarm occurrences (Appendix L), and follow-up staff surveys (Appendix M). The daily telemetry utilization tracking showed a 13% average decrease from the go-live date of April 11th, 2017 through April 24th, 2017. Though this is 7% under the stated goal of a 20% reduction, to-date there has not been sufficient time for staff adjustment. Post-intervention direct observation alarm data was gathered over 16 nonconsecutive hours with a total of 1,204 occurrences. Data illustrated a decrease of 29%, including a decrease in telemetry alarms by 18%, and an actionable alarm occurrence of 8%. The total reduction of 29% exceeds the goal of a 20% reduction, however it was expected that the decrease would have come from a greater reduction in telemetry alarms. The follow-up staff surveys are scheduled to go out May 11th, 2017 to provide a one month period for adjustment to the new policy and order process. Results to follow. Financial evaluation will be conducted at the one and two-year marks of April 11th, 2018 and April 11th, 2019.

To maintain current progress and continue to improve in the future, a sustainability plan has been established. This includes annual education modules regarding the alarm management policy and alarm event documentation, continued daily/ periodic auditing of the telemetry order process, and continued gathering of staff feedback through surveys and interviews. This plan is designed to be flexible to ensure room for any further identified changes that may be required in the future. Please see the survey (Appendix N) and the daily audit (Appendix O) forms in the Appendices.

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Appendix A

AHA Guidelines

AHA Cardiac Monitoring Guideline Examples:

Figure 1:

24 Hour	48 Hours
Suspected MI/ Chest Pain	Acute MI
Post Cardiac Angioplasty	Acute CHF
Post Pacemaker/ AICD	Syncope w/ Suspected Arrhythmia
Uncomplicated Ablation	Thoracic Surgery
Syncope w/ Truly Unknown Origin	Acute Stroke
Major Surgery	

Indefinite
Cardiac Surgery (This Admit)
Complex Cardiac Disorders (V-Tach Storm)
Undefined
Tachyarrhythmia
Brady arrhythmia
Pericarditis
S/P Uncomplicated Cardiac Cath.
Unstable Angina
Drug Toxicity
Cardiac Arrest
High-Risk Coronary Artery Lesions
Second (II) or Third Degree Block
Ventricular Tachycardia (Sustained)
Myocarditis
Loading Type I/III Antiarrhythmic Agents
Acute Non-Lethal Arrhythmia
High-Risk Cardiac or Respiratory Arrest
More than 3 days post MI

Appendix B

CCU Direct Observation Data Results:

Table 1:

Measure		Average	Range
Alarm Source Percentage	- Central Monitor	72%	57-79%
	- Bedside Monitor	5%	2-7%
	- IV Pump	21%	18-25%
	- Bed Exit Alarm	2%	0-5%
Duration in Seconds		30	1-350
Responses Required Percentage		3%	1-5%
Total Occurrences Per Hour		106	92-156

Appendix C

Survey Results:

Figure 2: **Staff Surveys**

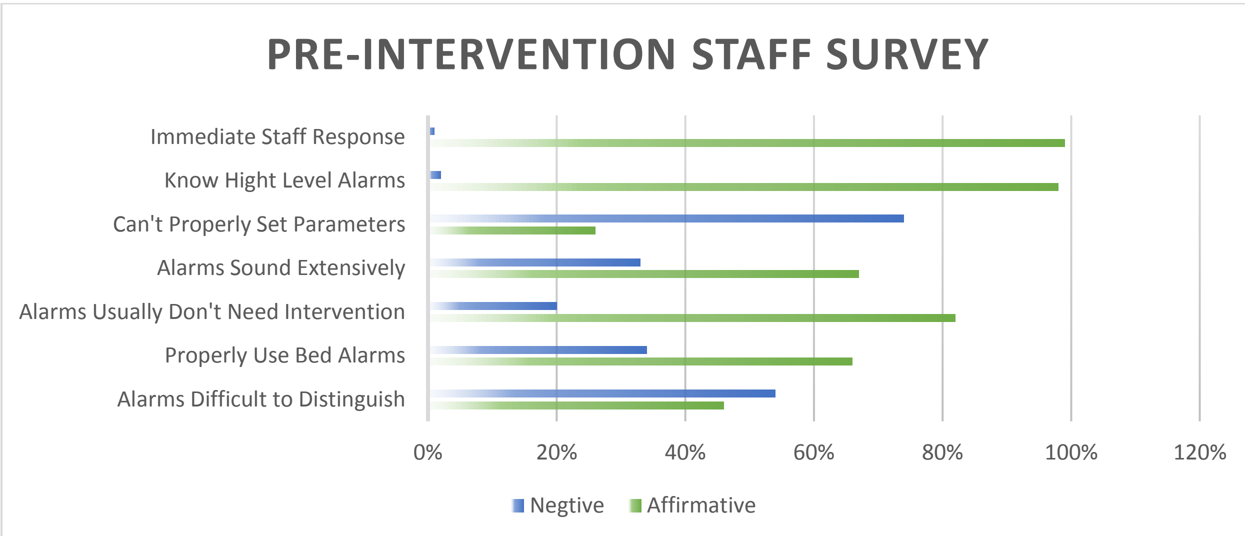
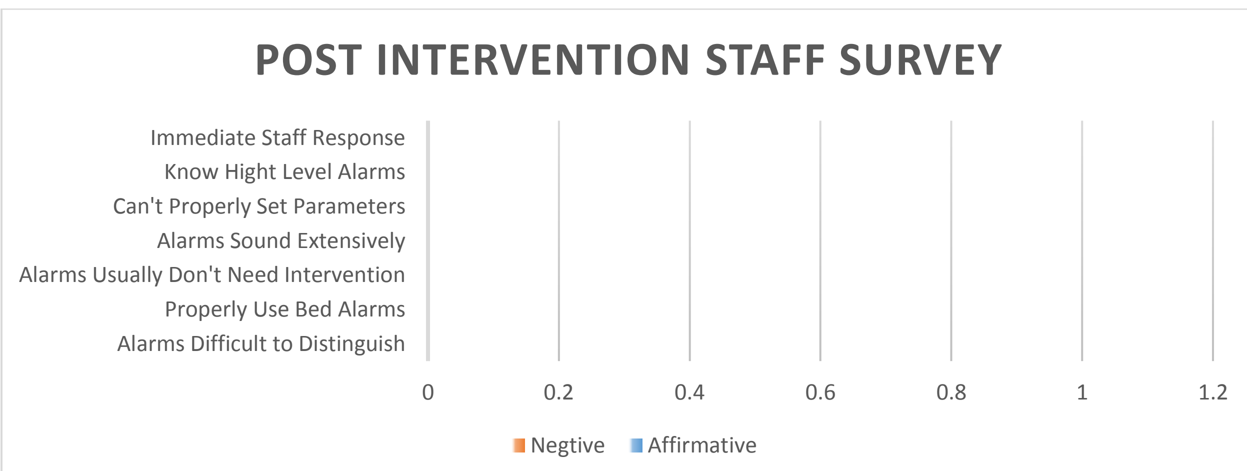


Figure 3: **Follow-up survey** (Data Pending)



Appendix D

Chart Review Results

Figure 4: **Total Telemetry Orders AHA Guideline Criteria Met vs. Not Met (11/2016)**

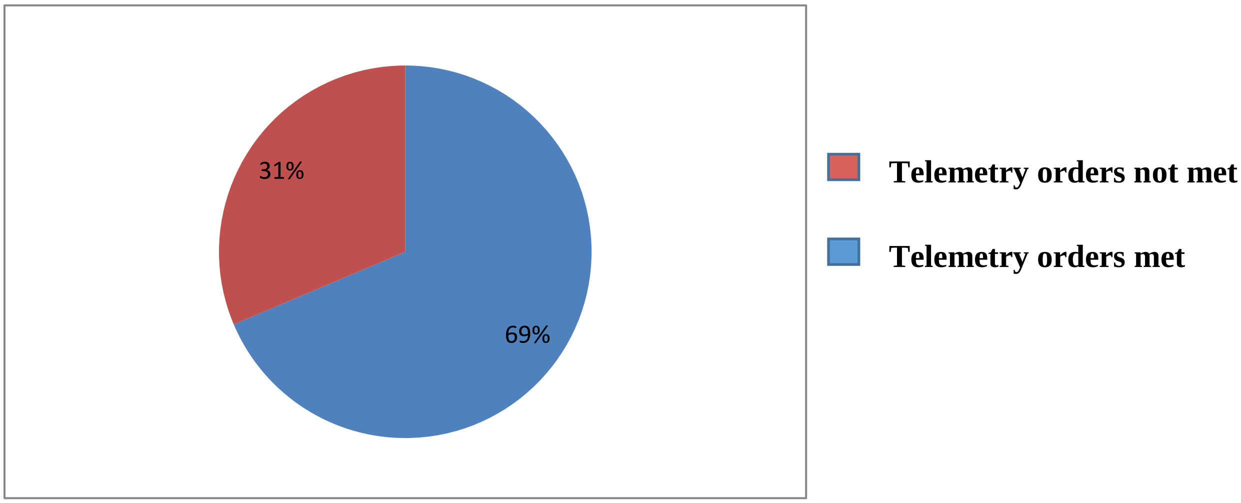
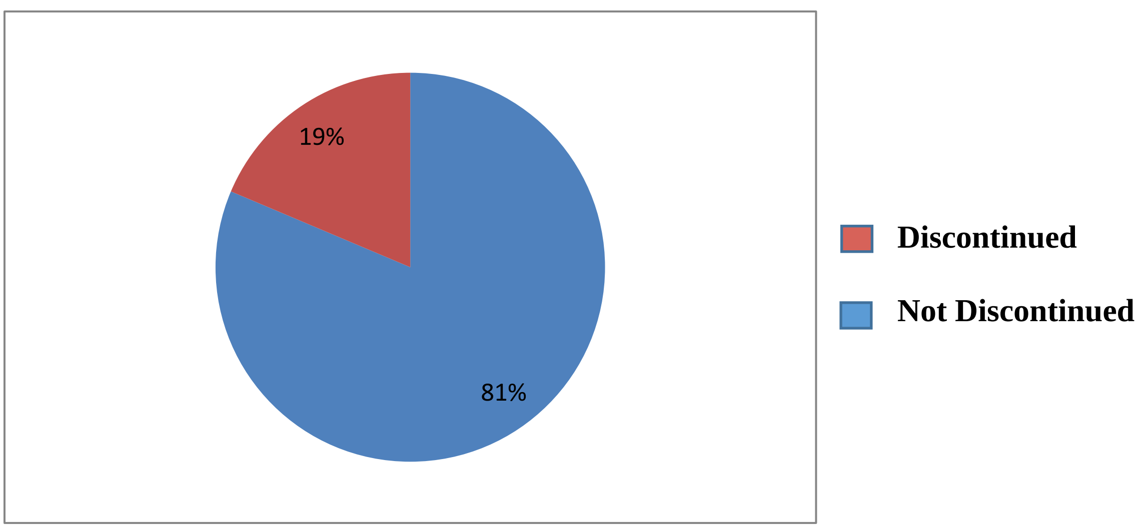


Figure 5: **Total Telemetry Orders Discontinued Prior to Discharge (11/2016)**



Appendix D Cont.

Chart Review Results:

Figure 6: **Total Telemetry Orders - Average Days on Telemetry (11/2016)**

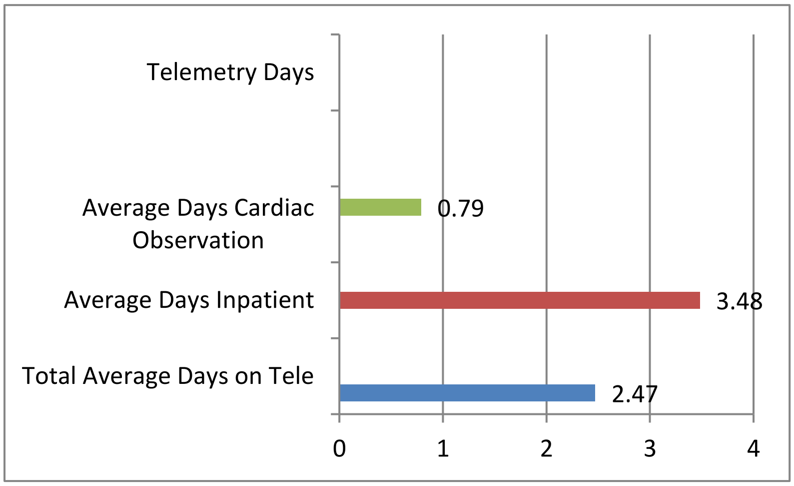
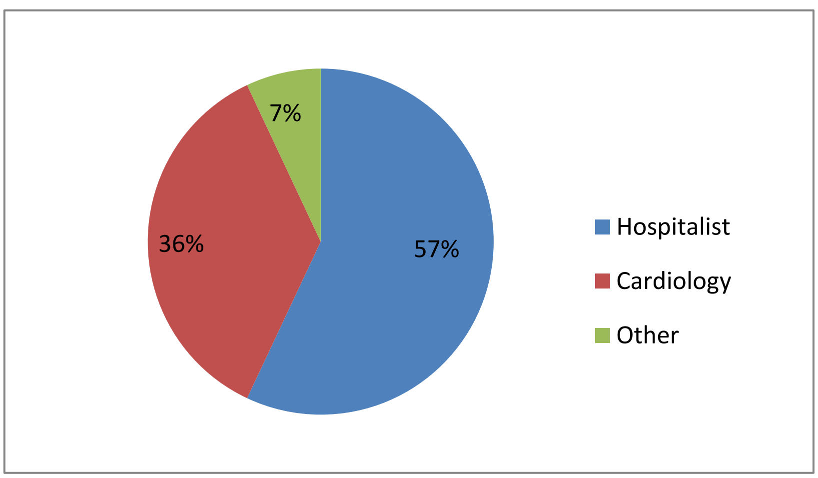


Figure 7: **Total Telemetry Orders by Provider Group (11/2016)**



Appendix D Cont.

Chart Review Results:

Figure 8: **Orders Outside AHA Guideline Criteria by Provider Group**

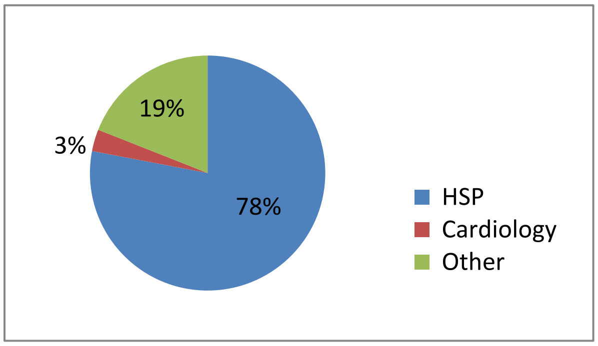


Figure 9: **Total Telemetry Orders by Unit**

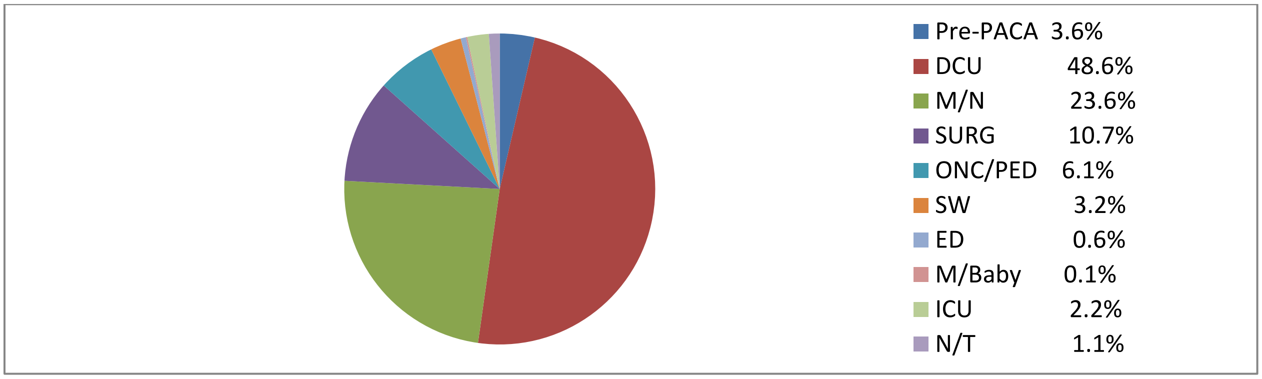
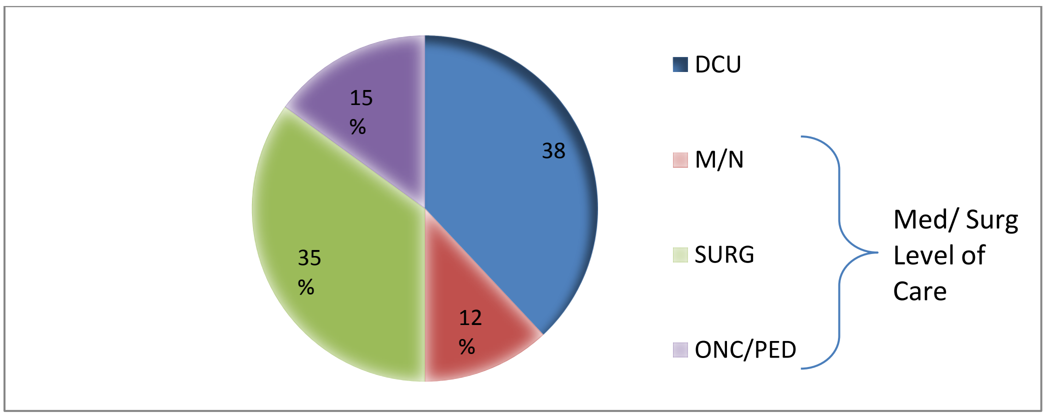


Figure 10: **Telemetry Orders Outside AHA Guideline Criteria by Unit**



Appendix E

Financial Analysis:

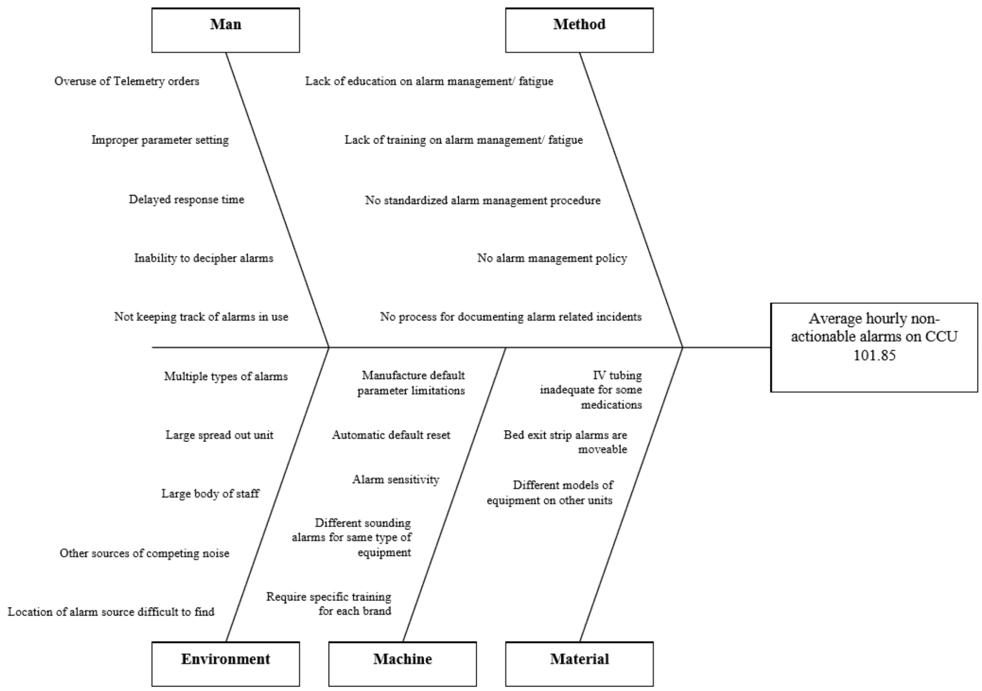
Table 2: **Cost vs. Benefit Analysis**

Expense	Average Rate	Number of Staff	First Year Cost	Second Year
1 hr RN Education	$55/ hr	920	$50,600	$50,600
1 hr CNA Education	$18/ hr	150	$2,700	$2,700
15 min CNA Survey	$5/ 15 min	150	$750	$0
15 min RN Survey	$14/ 15 min	920	$12,880	$0
CNL pt. Care Management	N/A	N/A	$0 (Student hrs)	$120,000
Savings (Nurse Ratio Changes)	N/A	N/A	$554,400	$554,400
Savings (1 Adverse Event)	N/A	N/A	-$118,750	-$118,750
Total Cost			$66,930	$173,300
Net Benefit			$606,220	$499,850

Appendix F

Root Cause Analysis:

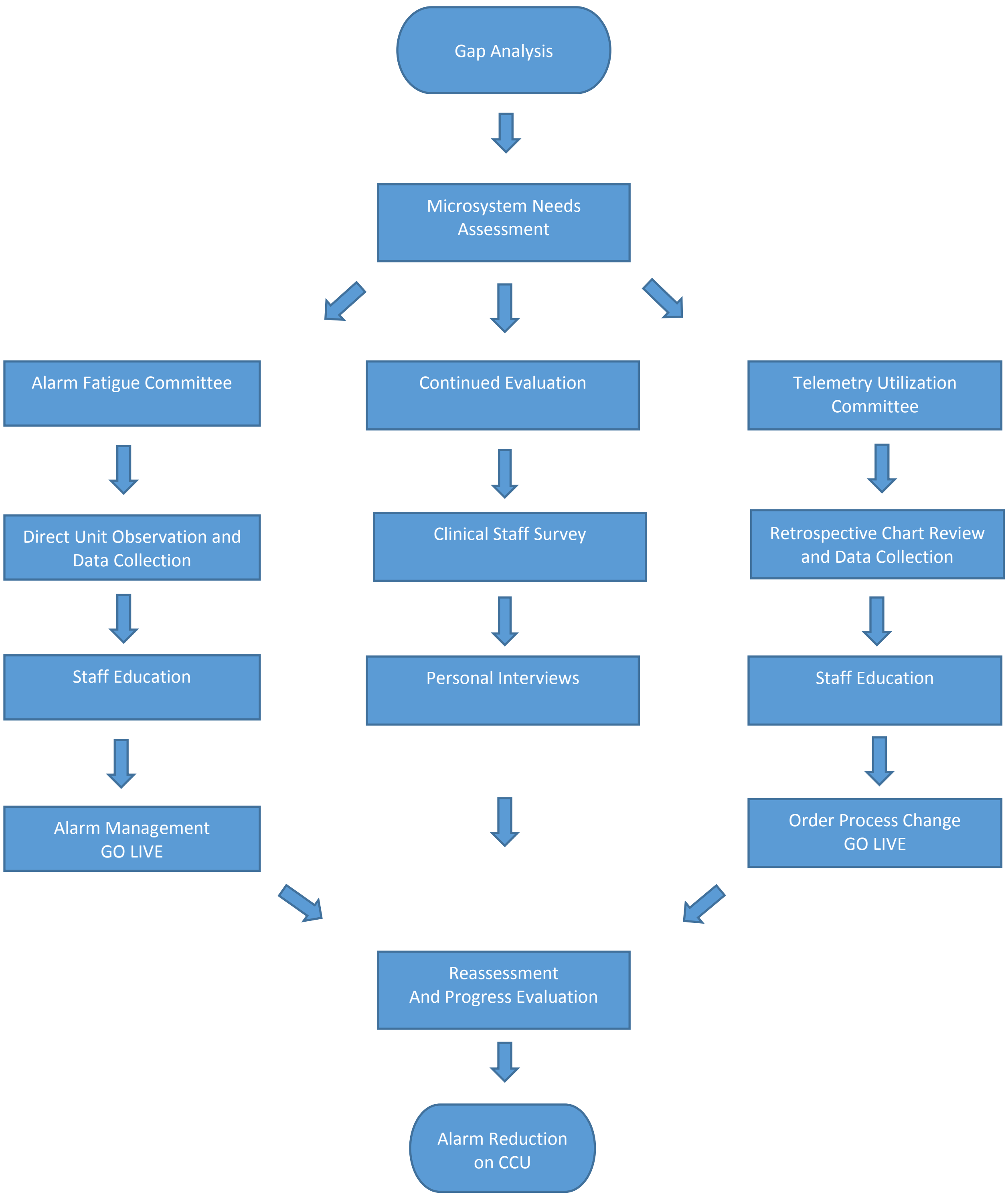
Figure 11: **Fishbone Diagram**



Appendix G

Process Map:

Figure 12: **Project Process Map**



Appendix H

Strengths, Weaknesses, Opportunities & Threats (SWOT) Analysis:

Table 3: **SWOT Analysis**

	Positive Factors	**Negative Factors**
Internal Factors	**STRENGTHS** • Micro-system culture of safety • Focus on patient-centred care • Staff communication • Value of teamwork • Well documented need for change • Support of TJC guidelines and National Patient Safety Goals • Current and relevant research material widely available • Interdisciplinary buy-in • Staff buy-in	**WEAKNESSES** • Lack of awareness • No current standard for proper alarm management • Requires time to create culture change • Inability to charge separately for telemetry • Requires staff compliance • Lack of documentation and evaluation of incidents
	Positive Factors	**Negative Factors**
External Factors	**OPPORTUNITIES** • Working with the interdisciplinary team to address system-wide issues • Comply with TJC guidelines and remain prepared for surveys • Improve documentation and evaluation of alarm related events	**THREATS** • Concurrent issues brought forth by management competing for priority • In adequate time and staffing to provide sustained auditing • High volume of new educational materials assigned at the same time

Appendix I

Stakeholder Analysis:

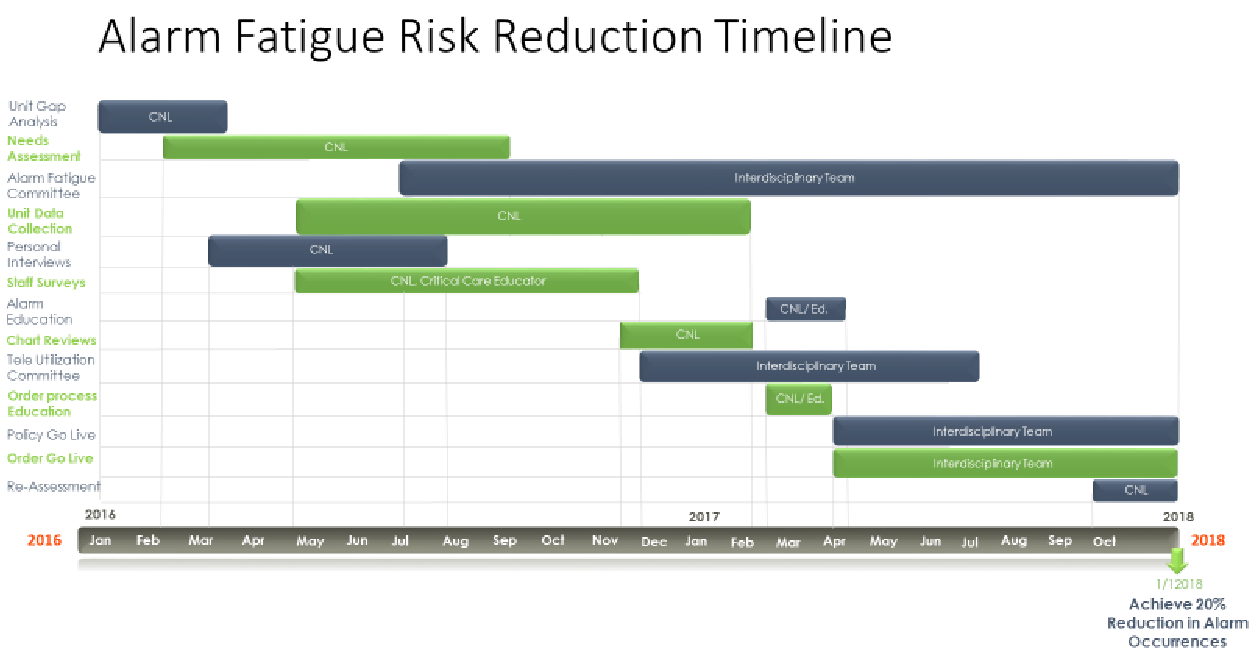
Table 4: **Stakeholder Analysis**

HIGH INFLUENCE	• The Joint Commission • Director of Critical Care • Managers of Critical Care • Med/ Surge Unit Managers • Alarm Fatigue Committee • Telemetry Utilization Committee	• CEO • VP of Patient Care Services
LOW INFLUECE	• Patients/ Family • CNL Student • Clinical Staff	• Non-Clinical Hospital Staff • Clinical Staff Without Buy-in
	HIGH INTEREST	LOW INTEREST

Appendix J

Gantt Chart:

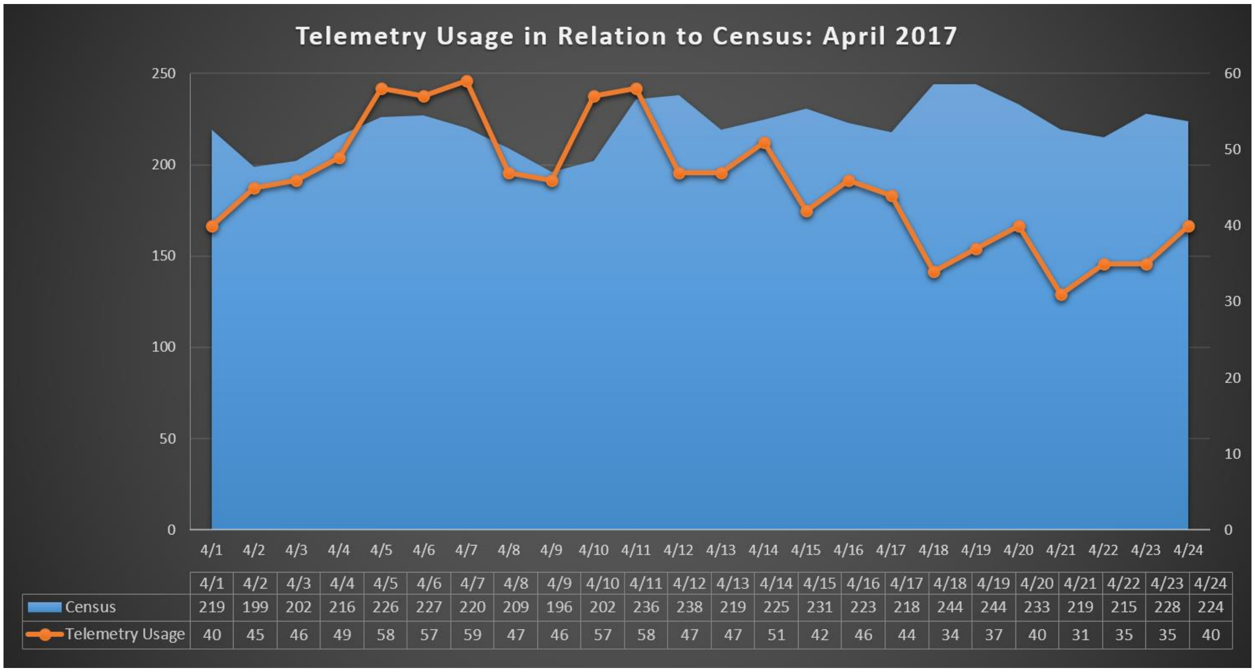
Figure 13: **Alarm Fatigue Risk Reduction Timeline**



Appendix K

Audit Results:

Figure 14: **Daily Audit Graph for April 2017**



Appendix L

Post-Intervention Data:

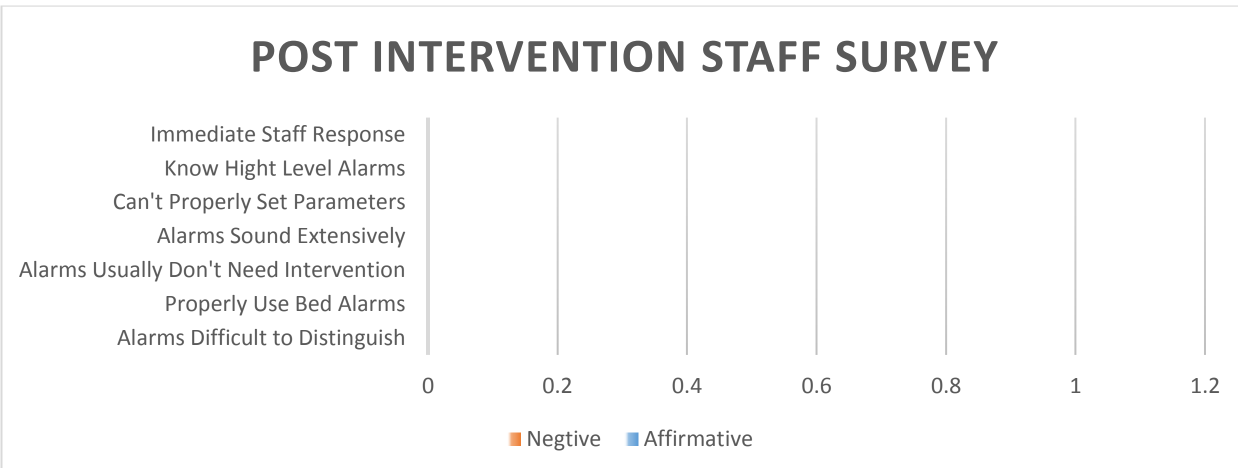
Table 5: **Post-Intervention CCU Direct Observation Data Results**

Measure	Result
Percentage of Telemetry Alarms	54%
Percentage of Alarms Requiring Intervention	8%
Average Occurrences Per Hour	75
Total Occurrences	1,204

Appendix M

Follow-up Staff Survey

Figure 15: **Post-Intervention Staff Survey Results**



Appendix N

Survey Form:

Alarm Fatigue: Follow Up Survey

This survey is intended to measure current unit conditions post implementation of the 'Management and Response to Clinical Alarms' policy. Please respond in your opinion for the typical atmosphere of your current unit.

1. When alarms ring out on the unit staff responds immediately.
2. All staff on the unit know which alarms signify a level 1 response (high).
3. I know the process to properly change alarm parameters to meet my patient's specific needs.
4. Alarms on the unit frequently sound for extended periods of time.
5. Alarms on the unit usually do not require an intervention.
6. I should use a bed alarm on all of my patients who are mobile so I know when they get up.
7. Emergent alarms are easy to distinguish from non-emergent alarms.
8. Comments:____
   ____

Thank you for taking the time to provide this valuable feedback!

Responses:

No/Never
Somewhat/Sometimes
Yes/Always

Appendix O

Daily Audit Form:

Date: _______________ Auditor: _________________ Department: __________________

Pt.	MR #	Nurse	Provider	24h Ren.	24h Stop	48h Stop	D/C or Renew	Not D/C or Renewed	Comments

Census: ________________ Telemetry Total: ________________