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Addressing the Problem of Alarm Fatigue:

Enhancing Patient Safety through Cardiac Alarm Customization

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University of San Francisco

NURS 653 Internship: Clinical Nurse Leader

Addressing the Problem of Alarm Fatigue: Enhancing Patient Safety through Cardiac Alarm
Customization

Clinical Leadership Theme

According to the American Association of Colleges of Nursing (2013), the Clinical Nurse Leader “assumes accountability for patient-care outcomes through the assimilation and application of evidence-based information to design, implement, and evaluate patient-care processes and models of care delivery” (p.4). The framework for the project focuses on the CNL curriculum element of *Care Environment Management* and the CNL will function in the role of *Information Manager*. Information systems and technology will be evaluated and utilized at the point of care to improve health care outcomes (American Association of Colleges of Nursing, 2013). The global aim is to improve patient safety on the Surgical Unit at an acute care facility in Southern California through enhanced cardiac alarm customization.

Statement of the Problem

Alarms are intended to enhance patient safety. However, unnecessary and non-actionable alarms contribute to alarm desensitization and fatigue, lessening response time to critical alerts. For the last four years, clinical alarm hazards have remained number one on the ECRI Institute’s Top 10 Health Technology Hazards list (ECRI, 2014). One of the Joint Commission’s 2015 Hospital National Patient Safety Goals is to “reduce the harm associated with clinical alarm systems” (The Joint Commission, 2015, p.7). According to the Joint Commission’s Sentinel Event database, there were 98 reported alarm related events between January 2009 and June 2012. Of these events, 80 resulted in death, 13 in permanent loss of function, and five in

unexpected additional care or extended stay. Due to the voluntary nature of event reported, these figures are estimated to be significantly higher (The Joint Commission, 2013).

A gap analysis on the Surgical Unit revealed a number of key issues and the need for improvement. A current policy and procedure does not yet exist at this facility for the management of clinical alarms. There is a lack of knowledge among nurses regarding alarm customization and management responsibilities. Nurses are not consistently customizing alarms to match the patient's history and condition, leading to an influx in unnecessary alarms and alarm desensitization. Additionally, nurses are not correctly assigning their cardiac pager to match their assigned patients. The result is an increased number of alarms for all caregivers and/or missed alarms by the assigned caregiver. According to The Joint Commission (2013), alarm fatigue can lead to unsafe practices by caregivers, and the outcomes may be devastating.

Nursing Relevance

Technology has greatly impacted the nurses' ability to provide safe and effective care. As advances in technology guide innovation in healthcare, the nursing profession must readily adapt. Alarm fatigue has steadily emerged as a priority safety concern due to the continuing development of alarm systems. Addressing this problem will greatly benefit the nursing profession. Nuisance alarms create added stress on the nurse and patient and can significantly interrupt nursing workflow. Reducing cardiac alarms will impact both patient and nurse satisfaction by reducing noise and allowing additional time for patient care.

Project Overview

The purpose of this project is to reduce the number of alarms on the cardiac monitor. The outcome measure will be the total number of alarms over a 6-hour period. Process measures will include compliance with alarm customization and pager assignments. Pre-implementation data included counting and categorizing cardiac alarms of a 6-hour period, auditing pager assignment compliance, and a staff survey. Post-implementation data will include monitoring alarms for a 6-hour period and re-auditing pager assignments. Specific interventions will include changing the default settings on the cardiac monitor and an in-service for nurses on alarm fatigue. The objectives for the in-service include: increasing awareness of alarm fatigue, educating nurses on the importance of alarm customization and pager assignments, troubleshooting nuisance alarms, connecting pulse ox alarms to the cardiac monitor, and informing RNs on the changes to default settings.

The specific aim of this project is to reduce the number of cardiac alarms by 20% on the Surgical Unit by August 8th, 2015. The global aim is to improve patient safety through enhanced cardiac alarm customization. Alarms are intended to enhance patient safety. Research has shown the 85-99% of alarms do not require action. Unnecessary and non-actionable alarms contribute to alarm desensitization and fatigue. Reducing the number of alarms will make caregivers more alert to the alarms that require action and will create a safer environment for patients (The Joint Commission, 2013).

Rationale

This project will take place on the Surgical Unit at a 625-bed, Magnet recognized, teaching hospital in southern California. This facility is located in an urban setting with a very

diverse population. The Surgical Unit is a 32-bed unit, caring for adult patients ages 18 and older. The majority of the population has undergone a general or orthopedic procedure, or has sustained a traumatic injury. Care providers on this unit include Registered Nurses (RNs), Patient Flow Coordinators (PFCs), Patient Care Associates (PCAs), and Physicians. The unit is supported by a manager, care coordinator, discharge planner, dietician, social workers, respiratory therapists, and occupational and physical therapists.

A needs assessment of the Surgical Unit revealed gaps in the alarm management process. This issue took priority as it directly relates to patient safety and is a recommended area of focus by The Joint Commission. A survey was conducted to assess staff knowledge and feelings towards managing cardiac alarms. Of the 50 RNs on the unit, 22 completed the survey. 95% of RNs feel that alarms interrupt their work. 41% of staff reported that they ‘always’ customize cardiac alarms, while 59% reported they ‘sometimes’ customize alarms. 77% of staff feel comfortable customizing alarms to match the individual patient. 80% of staff reported that there have been instances when they have not heard an alarm. Lastly, 100% of staff answered yes to the statement “Frequent clinical alarms reduce my attention to alarms in general”. From this data, conclusions may be made that alarms interrupt care, and, when frequent, critical alarms may be missed. Staff feel relatively comfortable customizing alarms, however are not routinely doing so.

Additional data included counting and categorizing the number of alarms over a 6-hour period, over the span of 3 days (3hr/2hr/1hr). The total number of cardiac alarms was 136 in 6 hours. That calculates out to be 23/hour or 552/day. Of the 136 alarms, 9 were red (critical alarms). That means that only 6.5% of alarms were critical. The last piece of data collection was an audit for pager assignments. Each shift and with every admission, the RN is expected to assign his or her patients to their cardiac monitor pager. If a patient is unassigned, every pager

will receive alerts on that patient. That means that each nurse will receive additional pages from patients other than their own. This adds to the total number of alarms each nurse receives. If a patient is incorrectly assigned (i.e assigned to a pager that is not in use), no one will receive alerts on this patient. Thirteen shifts, both day and night, were audited for compliance. There were 36 pagers used during these shift. Of the 36 pagers, 19 were correctly assigned. That means that pagers are only correctly assigned 53% of the time, indicating a need for staff reeducation.

Alarm related events have the potential to generate extreme costs for an organization. Of the 98 alarm-related events reported to The Joint Commission from January 2009 to June 2012, 80 resulted in death, 13 in permanent loss of function, and five in unexpected additional care or extended stay (The Joint Commission, 2013). Due to the voluntary nature of event reporting, this data represents a small portion of actual events. In 2011 alone, the FDA reported 35 deaths related to cardiac monitor alarms. It is difficult to estimate the monetary loss associated with an alarm related event. According to the Institute of Medicine, each preventable adverse event costs around \$8750. Litigation costs average approximately \$110,000 per case (Physician-Patient Alliance for Health and Safety, 2013).

In examining extended hospital stays alone, this project would positively impact the organization. Based on the grossly under-reported Joint Commission event database, I would estimate that alarm related events cost the unit 5 hospital days per year (The Joint Commission, 2013). The project would require 150 hours of CNL work. Although this project will be completed with student hours at no cost, the CNL wage will be calculated into the cost for demonstrative purposes. Using the average California CNL salary of \$42.06/hour (eHow, 2015) x 1.5 to include benefits, the total CNL cost would add up to \$9,463.50. This project requires 30 minutes of education for 50 staff RNs. The average RN salary with including benefits at this

facility is \$48 dollars per hour. Therefore, a 30 minute in-service would cost the unit \$1,200 (\$24 x 50). The total cost of CNL work and staff education would be \$10,663.50. A hospital day on the Surgical Unit with telemetry costs \$4767.06 (State of California, 2014). Five additional hospital days due to an alarm event would total \$23,835.30. The end result would be an estimated savings of \$13,171.80 per year. If you were to have 1 adverse event in a year with litigation, the total cost could reach \$142,585. In that case the hospital could potentially avoid \$131,921.50/year. Overall, this is a low cost intervention for an extremely high-risk problem (Refer to Appendix A).

Methodology

Lewin's change theory closely relates to innovation in the healthcare setting and will guide this project on alarms management. Lewin's model consists of three phases- unfreezing, changing (or moving), and refreezing. The first stage of unfreezing involves preparing for the change and establishing its merit. During this stage, data has been collected on the unit regarding alarms, including staff perceptions of the problem. Organizational support has been established and data will be shared to create a sense of urgency for addressing this problem. The change stage will involve implementation of new processes and staff education. A large period of time has been allotted for this stage because staff will adopt at varying rates. It is important that during this phase, the vision and goal are clearly defined and communicated. During the refreezing phase, staff will have adopted the new process into their workflow. Identifying driving and restraining forces will add to the success of the project (Thompson, 2015).

Relating this change theory to the project will create a framework for the planning and implementation stages. It is important to have a plan to empower staff to embrace the change before attempting to implement. It is also important to identify potential barriers and understand

the change process in order to increase the chance of success. Staff must be prepared for change in order to reduce the likelihood of staff rejection and negative outcomes (Refer to Appendix D for SWOT Analysis).

Microsystem data that was collected has provided a solid foundation for implementation. The data has offered insight into the problem and education needs of the unit. Implementing the project will consist of adjusting the default settings on the cardiac monitor and an in-service for RNs. Education will focus on increasing awareness of alarm fatigue, customizing alarms to match the patient condition, correctly assigning the pager, and troubleshooting artifact.

The specific objective of this project is to reduce the number of telemetry alarms by 20% by August 8th, 2015. The specific changes that will be tested are the changes to default settings and education on alarm customization. Pre-implementation data consisted of counting the number of alarms over a 6-hour period, auditing compliance with pager assignments, and a staff survey on alarms. Post-implementation will consist of counting the alarms for the same period of time and re-auditing pager assignments. It is predicted that the staff education and changes to the default settings will effectively reduce the total number of cardiac alarms. If the total number of telemetry alarms is reduced by 20%, the desired goal will have been reached. Interventions will be evaluated for effectiveness and modified and/or reinforced as needed.

Data Source/Literature Review

The focus of this literature review was to examine contributing factors to alarm fatigue and interventions to address the problem, specifically alarm customization. The University of San Francisco Library database was utilized for this search applying the PICO strategy *cardiac monitor, alarm customization, and patient safety*. Articles were limited to research studies published within the last five years. Seven articles were selected based on relevancy.

Drew et al (2014), using observational study methods, annotated 12,671 arrhythmia alarms over a 31-day study period in order to provide insight into the problem of alarm fatigue. They reported an 187/bed/day alarm burden and discovered that 88% of alarms were false positives. The authors contribute the excess number of alarms to inappropriate user settings, patient conditions, and algorithm deficiencies. This research demonstrates that a large portion of alarms do not require action and that adjusting the settings based on the individual patient condition may decrease the number of alarms.

In an observational study, Bonafide et al (2015) explore the relationship between high rates of nonactionable physiologic monitor alarms and response time to subsequent critical alarms. 36 nurses were observed at a pediatric facility for 210 hours with 5070 alarms. Authors discovered that 87.1% of PICU and 99% of medical ward alarms did not require action and response time increased as nonactionable alarms increased. This research demonstrates that nonactionable alarms are directly associated with unsafe practices, as nurses became slower to respond as alerts increase. By decreasing the number of nonactionable alarms, patient safety may be enhanced.

Whalen et al (2014) used methods of alarm data mining and direct observation to determine safe variables for decreasing noncritical telemetry and monitor alarms on a medical-surgical unit. They eliminated the use of self-resetting alarms for bradycardia and tachycardia, and changed the manufacturers HR limits to better match the patient population. As a result, they saw an 89% reduction in total mean weekly alarms, a 50% reduction in code blues and an improvement in patient and staff satisfaction. This research demonstrates a method for reducing audible alarms, without compromising patient safety or requiring additional resources.

In this study, Dandoy et al (2015) test a standardized cardiac monitor care process (CMCP) on a 24-bed pediatric bone marrow transplant unit to determine effectiveness in reducing monitor alarms. The CMCP consists of ordering monitor parameters based on age, daily replacement of electrodes, daily assessment of cardiac monitor parameters, and a reliable method for discontinuing the monitor. This process resulted in a significant reduction in the median number of alarms per patient day, from 180 to 40. This research demonstrates the importance of a team-based, multimodal, and standardized approach in reducing alarms and ensuring compliance with recommendations.

In this integrative review, Cvach (2012) examines 72 articles, both research and non-research, published from 2000-2011, in order to determine evidence based practice recommendations and gaps in research. Using The John's Hopkins Nursing Evidence-Based Practice model, recommendations are categorized as excessive alarms and effects on staff; nurses response to alarms; alarm sounds and audibility; technology to reduce false alarms; alarm notification systems; strategies to reduce alarm desensitization; and alarm priority and notification systems. Recommendations that specifically relate to this project suggest that activated alarms should be set to actionable limits, adjustments should be made to meet the patient's actual needs and to ensure early warning to potential critical events, and noise reduction methods should be implemented to reduce staff and patient stress. Outcomes research is needed to focus on patient safety and not solely on alarm reduction.

Graham & Cvach (2010) study the effects of customizing alarm limits and adjusting monitor software defaults through a unit-based quality improvement project on a medical progressive care unit. Types and frequency of monitor alarms were assessed and a significant reduction (43%) in critical monitor alarms was observed following intervention. This data

proved a meaningful starting point for organization-wide improvement in alarm management.

This research is notably relevant as it directly relates to the interventions of alarm customization and changes to default settings, with significant results.

Konkani, Oakley, & Bauld (2012) seek to define best practices for the reduction of false clinical alarms. In this review, 27 journal articles relating to alarms management were examined through January 2012. Articles included the categories of audibility, identification, urgency mapping, response time of nursing staff, and potential solutions. Results indicate that the easiest and most direct method in reducing false alarms is to customize alarm settings to match the individual patient's condition. This article is valuable as it emphasizes minimal interventions, such as individualization of alarms, may have a significant reduction in alarm reduction.

As demonstrated in this review, literature strongly supports the reduction of alarms, alarm customization, and adjustments to default settings as methods for addressing the problem of alarm fatigue and enhancing patient safety. The methods in this project will focus on unit audits and assessment information to describe the problem and evaluate interventions. Alarms have been observed over a 6-hour period and will be observed for the same period post-intervention. These methods are similar to those discussed in this literature review and have proved effective. The interventions in this project will reflect evidence based recommendations discussed in this review.

Timeline

This project began at the end of May 2015 and will conclude August 8th, 2015. A microsystem assessment was completed by the CNL on June 5th. A literature review was conducted and completed on June 15th. A staff survey was developed June 14th and staff were

interviewed up until July 3rd. Pre-intervention data (6 hours of observing the monitor and pager assignment audits) was completed on July 3rd. The intervention stage was completed during the staff meetings on July 13th and July 15th. Default alarm settings were changed 3 days early on July 13th by the IT department. Post-intervention data (6 hours of observing the monitor and pager assignment audits) was completed by August 6th. Data will then be analyzed and results reviewed by August 8th, 2015 (Refer to Appendix F).

Expected Results

The primary expected outcome, and focus of this project is to improve patient safety. As the literature states, customizing alarms to match the individual patient will assist in decreasing the number of alarms. As evidenced in the staff survey, frequent alarms decrease attention to alarms in general, and the majority of staff have missed an alarm. Decreasing the number of alarms will enhance patient safety by making nurses more aware of alerts that require action.

A secondary outcome or conclusion that may emerge from this project is an increase in staff and/or patient satisfaction. Almost all of the nurses interviewed on the Surgical Unit felt that alarms interrupted their work. Every time the telemetry pager sends an alert, you have to reach in your pocket to read it. This can become extremely tedious and aggravating, especially when most alerts require no action. By decreasing these alerts, we may also increase nurse satisfaction. Multiple studies have found a correlation between the nursing work environment and patient outcomes (Boev, 2012). I may consider implementing a post-intervention survey that addresses satisfaction with alarms.

In addition, alarms may effect patient satisfaction. According to a study conducted by The Healthcare Technology Foundation concluded that alarms contribute to a noisy hospital

environment (Funk et al, 2014). By decreasing the number of alarms, we may also potentially increase patient satisfaction. Patient satisfaction not only impacts quality, but also greatly influences hospital reimbursement. It is feasible to track pre-intervention and post-intervention HCAHPS scores using the indicator of noise at night.

Summary Report

In review, the specific aim of this project was to reduce the number of cardiac alarms on the Surgical Unit by 20% with a target deadline of August 8th, 2015. The global aim was to improve patient safety through enhanced cardiac alarm customization. The Surgical Unit is a 32-bed unit, located within a 625-bed, Magnet recognized, urban teaching facility in southern California. The primary population consists of adults aged 18 and older who have undergone a general or orthopedic procedure, or have sustained a traumatic injury.

Baseline data included an alarm related staff survey, 6 hours of alarm review, and a compliance audit for cardiac pagers. For a detailed description of these results, refer to the “Rationale” section of this paper and Appendix H. In summary, 95% of RNs feel that alarms interrupt their work and 80% of staff reported that there have been instances when they have not heard an alarm. 100% of staff answered yes to the statement “Frequent clinical alarms reduce my attention to alarms in general”. 41% of staff reported that they ‘always’ customize cardiac alarms, while 59% reported they ‘sometimes’ customize alarms. 77% of staff felt comfortable customizing alarms to match the individual patient. This data provides clear indication that alarms interrupt care and that critical alarms may be missed. The second piece of baseline data included the counting and categorizing of cardiac alarms over a 6-hour period. The total number of cardiac alarms was 136 in 6 hours. That calculates out to be 23/hour or 552/day. Of the 136 alarms only 6.5% were critical. Lastly, the results of the cardiac pager audit revealed that pagers

were only correctly assigned to appropriate patients 53% of the time. Interventions were catered to address these needs on the unit.

The main intervention method utilized was an in-service during staff meetings on July 13th and 15th. A poster was created and displayed in the staff lounge to serve as both a communication tool and reminder to staff. Handouts were made as an additional reference. Content included an overview of alarm fatigue and scope of the problem, Joint Commission information and data, pre-intervention data on the Surgical Unit, evidence-based guidelines, and upcoming changes to the default settings (Refer to Appendix I). Fifty percent of RNs were reached during the staff meeting in-service. In addition, an email was sent to staff and reference cards containing changes to the default settings were placed on each cardiac monitor station.

Post-intervention data consisted of an additional 6 hours of counting and categorizing cardiac alarms. In the post-intervention period, there were a total of 93 alarms/6 hours, translating to 16/hr or 384/day. This is a 32% decrease from the pre-intervention results. 5 of the 93 alarms were critical, or 5.4%. 51% of the alarms were not indicative of a clinical condition, although do require an action or indicate artifact (Leads off, Cannot Analyze, and Replace Tele Battery). The types of alarm varied greatly from pre and post intervention audits (Refer to Appendix J.). Compliance with assigning the cardiac pager to the correct patient improved from 53% in the pre-intervention period to 75% post-intervention. Although this is a significant improvement, ideally this percentage should be closer to 90% and therefore, will receive additional attention in the future.

Evaluation and Conclusions

Overall, the 32% percent reduction in cardiac alarms has exceeded the goal set at a

20% reduction. Based on literature, this reduction contributes to patient safety. Customizing alarms and changing the default settings were successful interventions in decreasing the total number of cardiac alarms. Changing the default settings largely contributed to the success of this project as many of the non-actionable, unnecessary alarms were turned off. Alarms were customized 38% of the time post-intervention. It is difficult to measure whether default or customized settings were appropriate for each individual patient. Changing the default settings to better match the patient population could have contributed to a decreased need for customization.

The alarm types varied greatly from pre-intervention and post-intervention data. During the pre-intervention period, the highest volume of alarms came from “heart rate yellow” (slightly outside parameter), “cannot analyze”, and “PVC’s greater than 10/min”. In the post-intervention period, the highest percentage of alarms were “leads off”, “replace tele battery”, and “irregular heart rate”. When examining the patients that had customized settings, most adjustments were made to heart rate limits. It appears that this contributed to a decrease in “heart rate yellow” alarms. Most standard PVC alarms were turned off with the change in default settings. The monitor displays the number of PVCs for each patient and it was decided that this condition did not warrant an alarm or require immediate action. This change eliminated one of the most common alarms observed during the pre-intervention period. In both data collection periods there were a high number of false alarms associated with artifact. This indicates a need for better lead management; including appropriate skin preparation and routine lead changes. This will be a focus of the next PDSA cycle.

Feedback from staff regarding satisfaction with the new alarm settings has been relatively positive. Nurses have been receptive to the change, despite competing priorities. Nurses generally feel that cardiac alarms have decreased and they are more aware and responsive to the

alerts they receive. A formal post-intervention staff survey will be conducted following the completion of additional PDSA cycles and focusing on additional interventions. Due to time restraints, patient satisfaction scores were not included in this review. Press Ganey scores will be reviewed prior to July and after August to determine if decreasing alarms has affected the category of noise levels at night.

A few major changes are coming at the end of this year and into 2016 that will effect alarms management. There will be an upgrade to the Phillips monitoring software that will affect all care areas. With this new system, data is easily extracted, allowing for a broader range of information. Manual data collection has proven to have a number of limitations. Before initiation of the new software, leaders will be examining default settings for the institution and for individual units and will determine appropriate settings. This project could potentially effect these decisions and provide valuable information during this process. The unit will also be replacing the telephones to a smart phone, which is capable of connecting to the cardiac monitor. All alerts will be received on this single device. Nurses will receive training on operating the new phone and this will serve as an opportunity to reeducate staff on appropriately assigning patients to this device.

The plan for sustainability involves modification of the program based on reassessment, remaining inline with the organization's mission and procedures, focusing on the perceived benefits to staff and patients, and maintaining support from stakeholders. Modifications will be made to the program to address lead management and compliance with pager assignments. The hospital's mission is to excel at the delivery of healthcare to the community. Part of delivering excellent care is ensuring a culture of safety and reflecting national standards through practice, such as the Joint Commission's National Patient Safety Goals. One of the elements of practice

relating to the safety goal is that organizations make this issue a priority. The manager of the Surgical Unit, the Critical Care CNS, and Med-Surg Director support this project. There is also a hospital wide committee and task force for alarm management to encourage continual improvement. Promoting compliance with alarm customization has involved concentrating on the benefits for the staff as well as the patient. Decreasing the number of nuisance alarms decreases the amount of interruptions for staff and the headache alarms can cause. Decreasing alarms also makes staff more responsive to alarms that require intervention.

Overall, alarm customization and changes to default settings have been successful in decreasing the total number of alarms and enhancing patient safety on the unit. This has been a beneficial process in determining successful interventions, as well as areas that require additional attention. Alarm fatigue is a multifaceted problem, with great potential to cause patient harm and therefore should be considered an organizational priority. Although there is a significant amount of work to be completed in the future, the Surgical Unit is making strides in the right direction.

References:

- American Association of Colleges of Nursing (2013). *Competencies and curricular expectations for clinical nurse leader education and practice*. Retrieved from <http://www.aacn.nche.edu/cnl/CNL-Competencies-October-2013.pdf>
- Boev, C. (2012). The relationship between nurses' perception of work environment and patient satisfaction in adult critical care. *Journal of Nursing Scholarship*, 44(4), 368-375.
- Bonafide, C.P., Lin, R., Zander, M., Graham, C.S., Paine, C.W., ...Keren, R. (2015). Association between exposure to nonactionable physiologic monitor alarms and response time in a children's hospital. *J Hosp Med*, 10(6), 345-351.
- Cvach, M. (2012). Monitor alarm fatigue: an integrative review. *Biomedical Instrumentation & Technology*, 46(4), 268-277.
- Dandoy, C.E., Davies, S.M., Flesch, L., Hayward, M., Koons, C., Coleman, K., ... & Weiss, B. (2015). A team based approach to reducing cardiac monitor alarms. *Pediatrics*, 134(6), 1686-1694.
- Drew, B.J., Harris, P., Zegre-Hemsey, J.K, Mammone, T., Schindler, D., Salas-Boni, R., ... & Hu, X. (2014). Insights into the problem of alarm fatigue with physiologic monitor devices: a comprehensive observational study of consecutive intensive care unit patients. *PLoS ONE*, 9(10), 1-23.
- eHow (2015). Salary of a CNL. Retrieved from http://www.ehow.com/info_10028000_salary-cn.html
- ECRI Institute (2014). ECRI Institute announces top 10 health technology hazards for 2015.

Retrieved from <https://www.ecri.org/press/Pages/ECRI-Institute-Announces-Top-10-Health-Technology-Hazards-for-2015.aspx>

Funk, M., Clark, T., Bauld, T.J., Ott, J.C., & Coss, P. (2014). Attitudes and practices related to clinical alarms. *American Journal of Critical Care*, 23(3), 9-18.

Graham, K.C., & Cvach, M. (2010). Monitor alarm fatigue: standardizing use of physiological monitors and decreasing nuisance alarms. *American Journal of Critical Care*, 19(1), 28-34.

The Joint Commission (2013). The Joint Commission sentinel event alert: medical device alarm safety in hospitals. Retrieved from http://www.jointcommission.org/assets/1/18/SEA_50_alarms_4_5_13_FINAL1.PDF

The Joint Commission (2015). *National patient safety goals effective January 1, 2015*. Retrieved from http://www.jointcommission.org/assets/1/6/2015_NPSG_HAP.pdf

Konkani, A., Oakley, B., & Bauld, T.J. (2012). Reducing hospital noise: a review of medical device alarm management. *Biomedical Instrumentation & Technology*, 46(6), 478-487.

Physician-Patient Alliance for Health and Safety (2013). 5 resources on the costs of adverse events. Retrieved from <http://www.ppahs.org/2013/02/5-resources-on-the-costs-of-adverse-events/>

State of California: Office of Statewide Health Planning and Development (2014). Hospital chargemasters and charges for 25 common outpatient procedures. Retrieved from <http://www.oshpd.ca.gov/chargemaster/default.aspx>

Thompson, R. (2015) Lewin's change management model. Retrieved from

http://www.mindtools.com/pages/article/newPPM_94.htm

Whalen, D.A., Covelle, P.M., Piepenbrink, J.C, Villanoza, K.L., & Cuneo, C.L. (2014). Novel approach to cardiac alarm management on telemetry units. *Journal of Cardiovascular Nursing, 29*(5), 13-22.

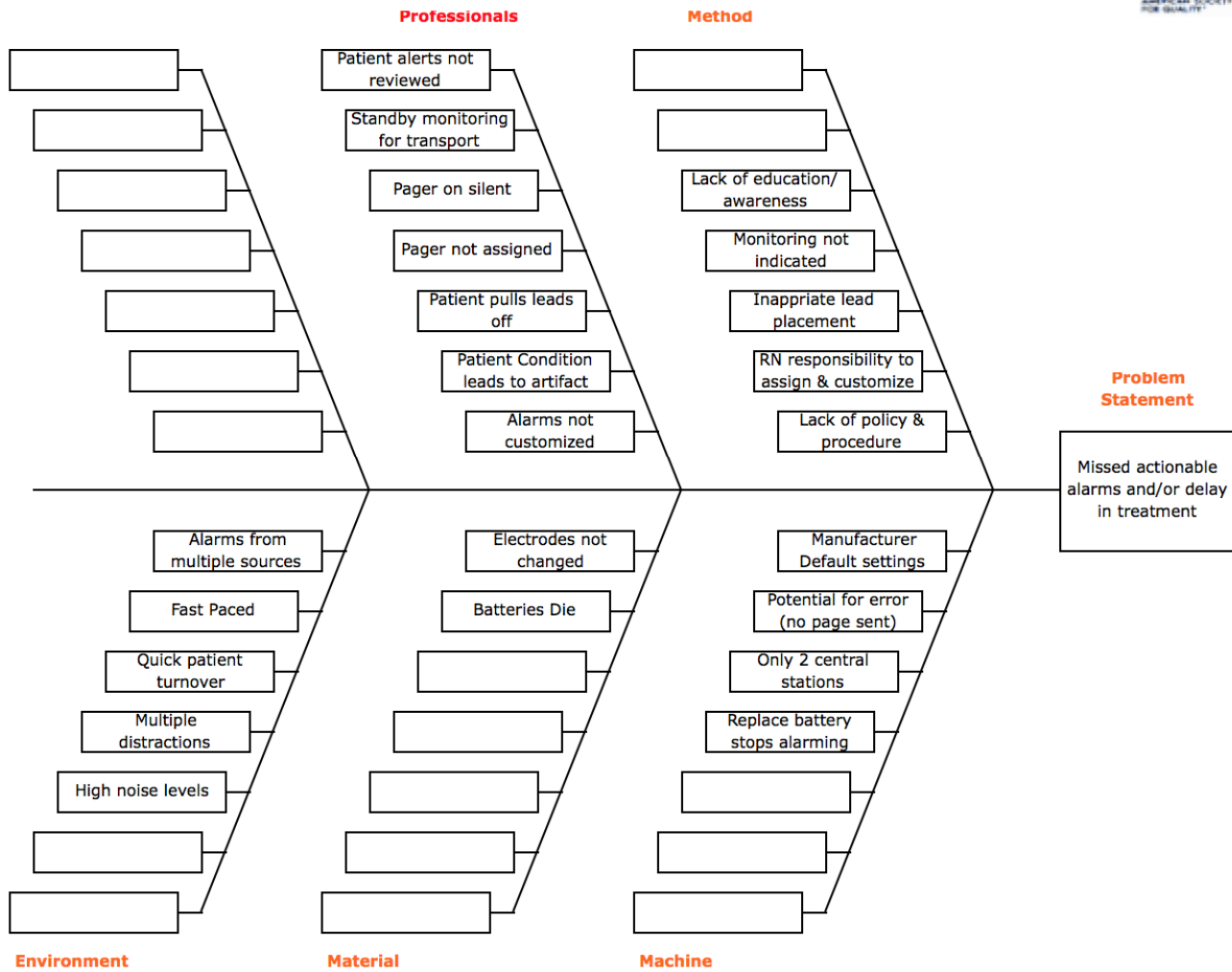
Appendix A

Cost-Benefit Analysis

| Operational Costs (Year 1) | Potential Savings (Year 1) | Net Benefit |
|---|--|---------------------|
| CNL Salary with Benefits (150hrs x \$63.09) \$9463.50 | Additional Hospital Days (\$4767.06 x 5) \$23,835.30 | |
| 30 min Staff Education (\$24 x 50 RN) \$1,200 | Adverse Event x 1with Litigation \$118, 750.00 | |
| | | |
| Total \$10,663.50 | Total \$142,585.30 | |
| | | \$131,921.50 |

Appendix B

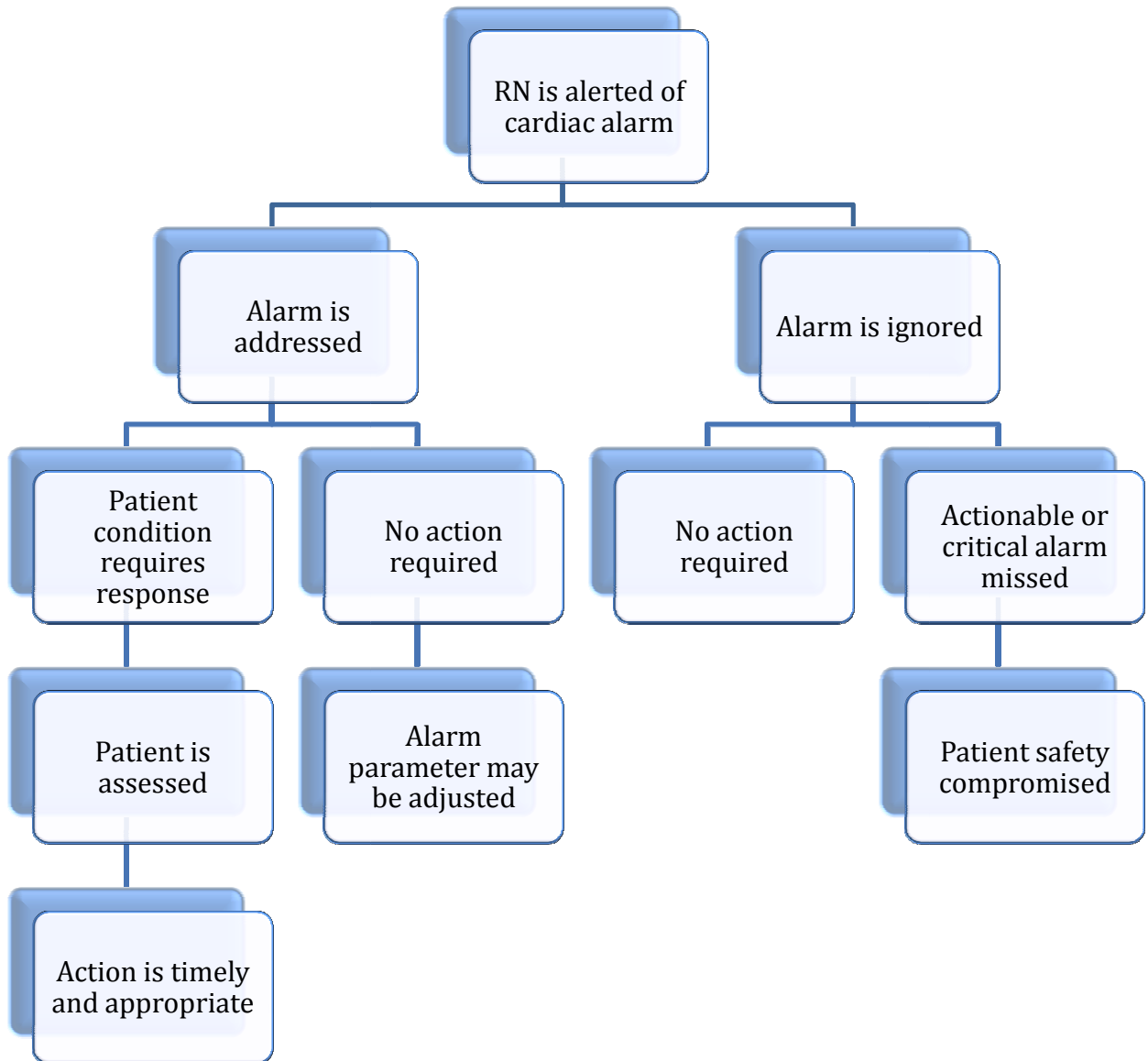
Fishbone Diagram



Template provided by:

ASQ (2015). Fishbone (Ishikawa) Diagram. Retrieved from <http://asq.org/learn-about-quality/cause-analysis-tools/overview/fishbone.html>

Process Map



SWOT Analysis

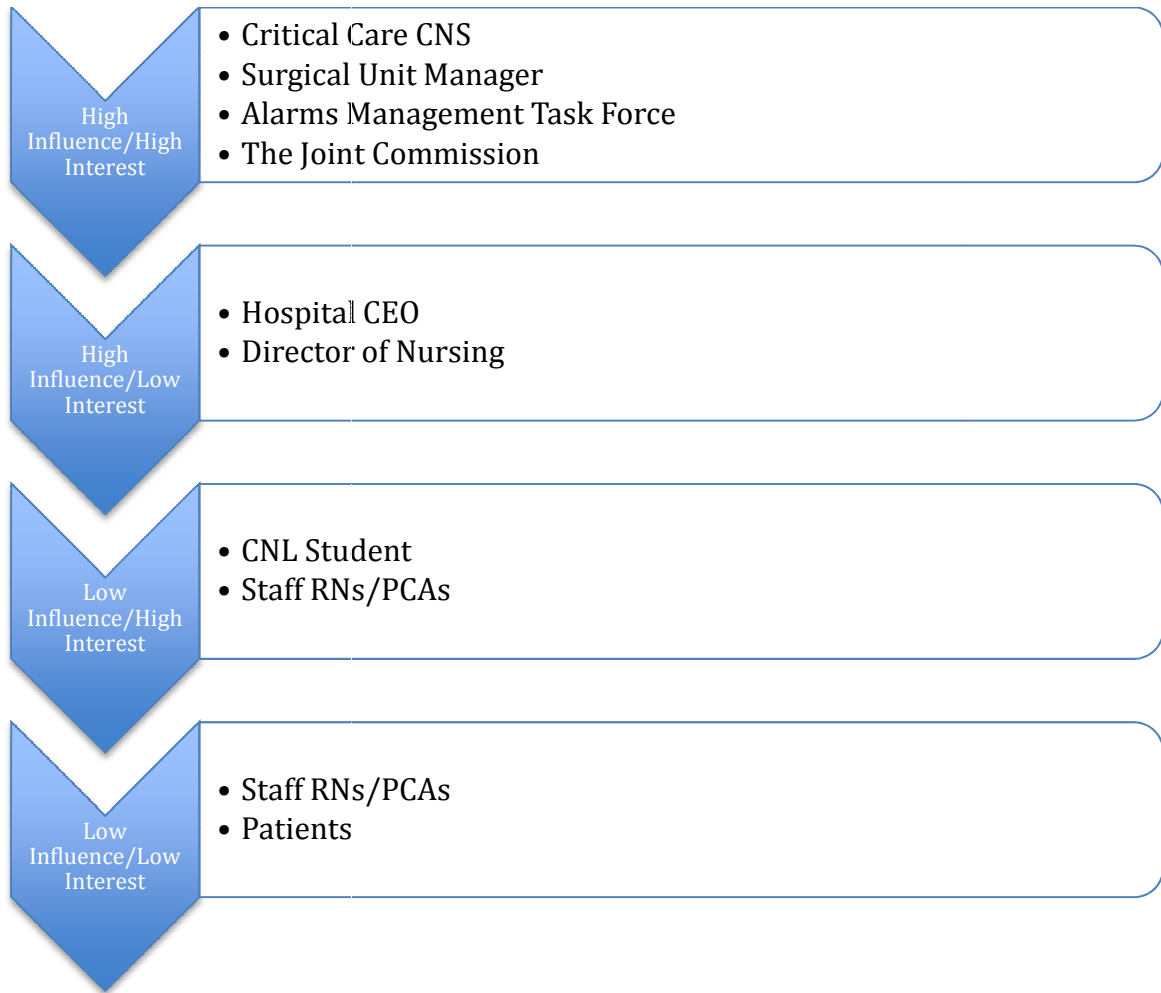
Strengths: The prominent strengths of alarm customization include a reduction in interruptions and increased nurse efficiency. This is a simple, low cost intervention that can improve patient safety and overall workflow. Strengths of the microsystem include strong leadership and teamwork, and a commitment to patient safety.

Weaknesses: Weaknesses include the potential for staff resistance and varying degrees of compliance. Alarm review and customization is an added task in an already busy workflow. To mitigate staff resistance I will focus on the benefits of alarm customization. Non-actionable alarms create unnecessary interruptions and additional work. By customizing alarms to match the patient's condition and history, interruptions are minimized and nurses are allowed more time to complete other tasks.

Opportunities: One of the greatest opportunities for this project is the amount of support from the organization. One of the Joint Commission's 2015 Patient Safety Goals is to address the problem of alarm fatigue and as a result our organization has assembled a hospital-wide task force. The customization project will be a pilot program specific to the Surgical Unit. It is an opportunity to increase awareness and improve staff knowledge.

Threats: Potential threats include the limited amount of time allotted for this project and competing priorities on the unit. In order to complete the project and maintain staff interest, alarm customization will be limited to telemetry alarms.

Stakeholder Analysis



Project Timeline (Revised)



Alarms Management Questionnaire

1. Do you feel that alarms interrupt your work?

Yes

No

2. Do you feel confident customizing telemetry alarms to meet your specific patient's condition?

Yes

No

3. How often do you customize your telemetry alarms?

Always

Sometimes

Never

4. How often do you assign your patients to your pager?

Always

Sometimes

Never

5. There have been instances when I have not heard an alarm.

Yes

No

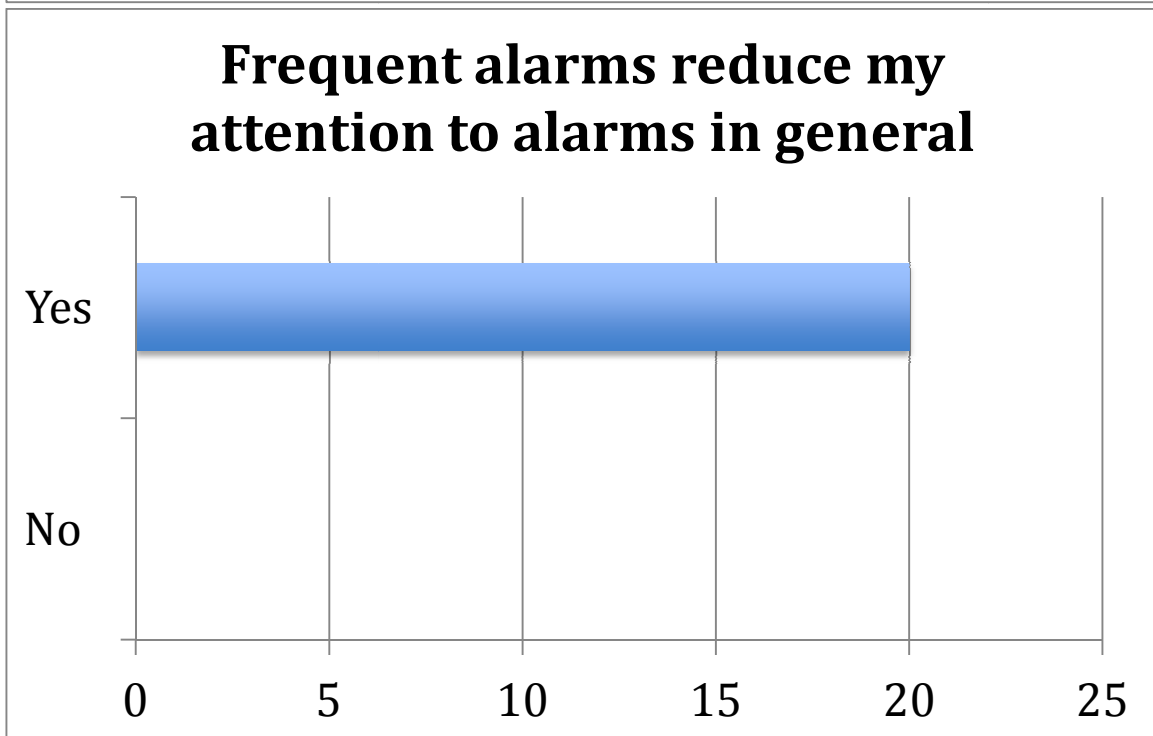
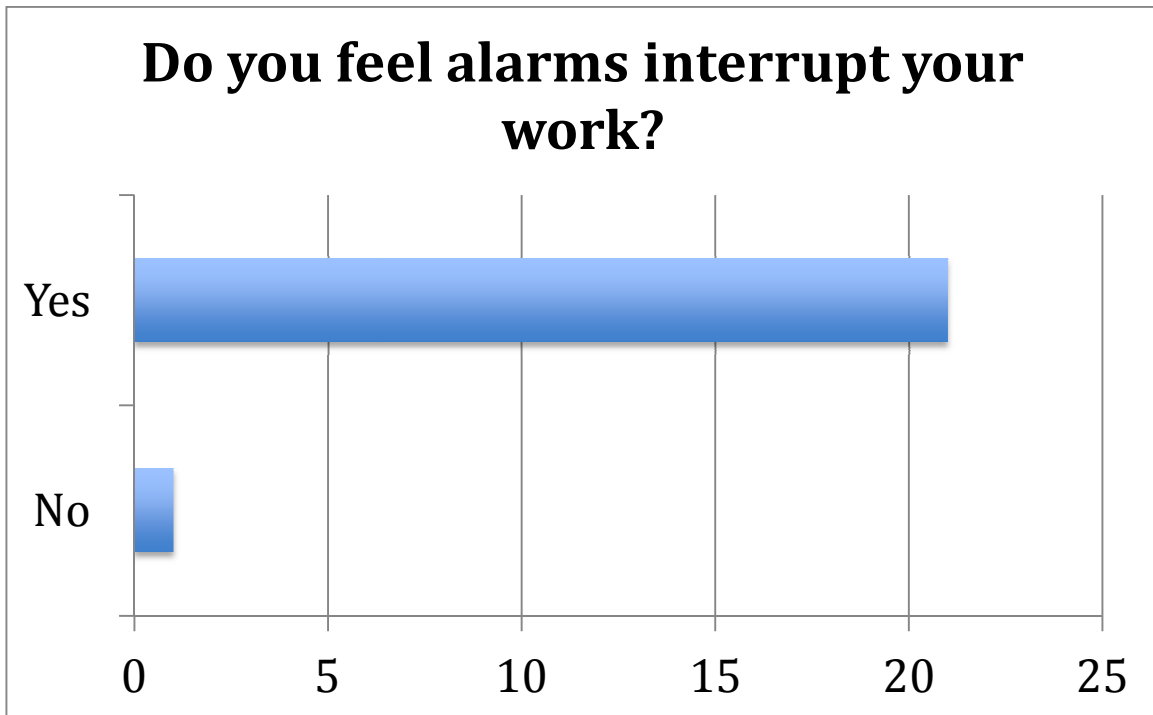
6. Frequent clinical alarms reduce my attention to alarms in general.

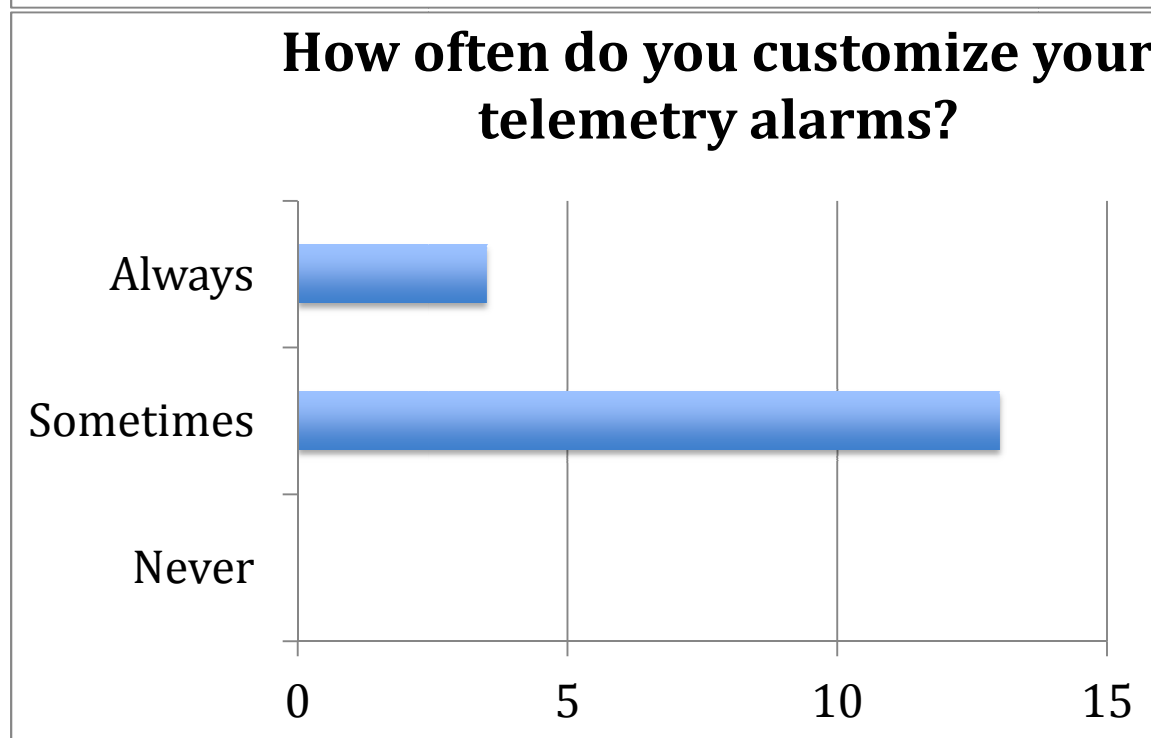
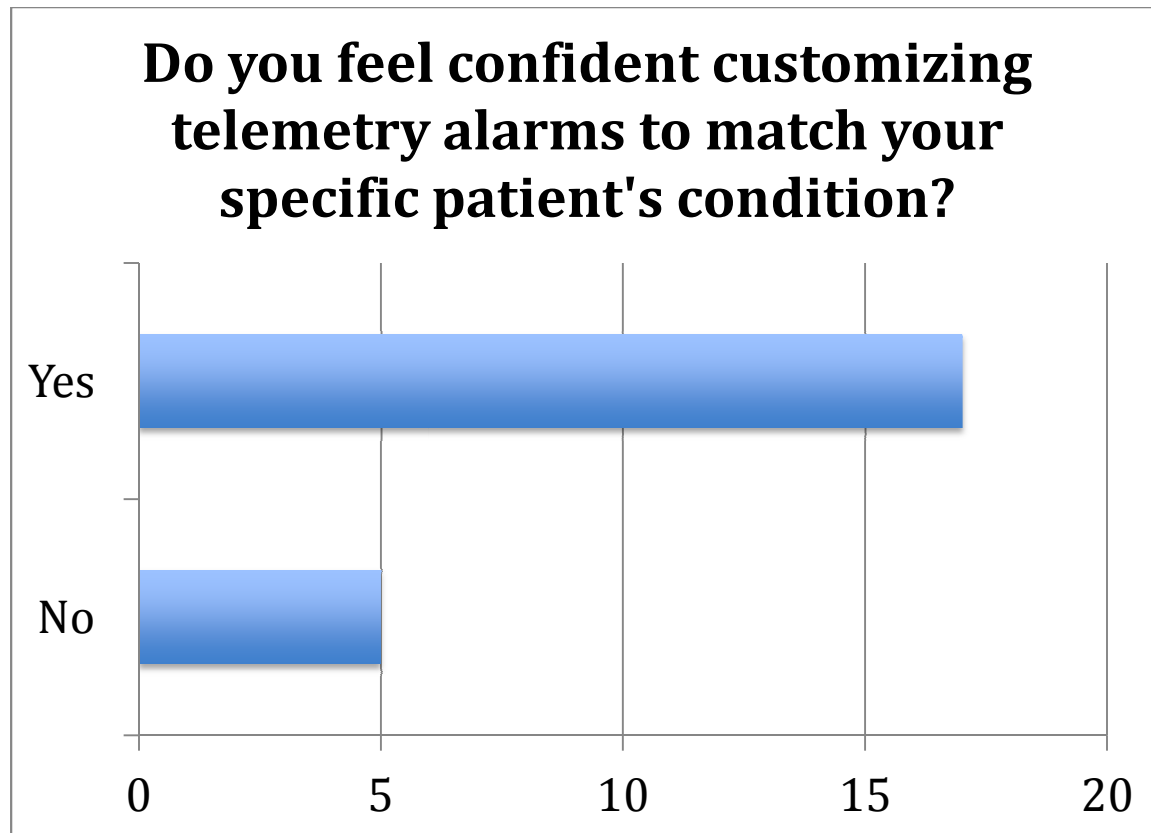
Yes

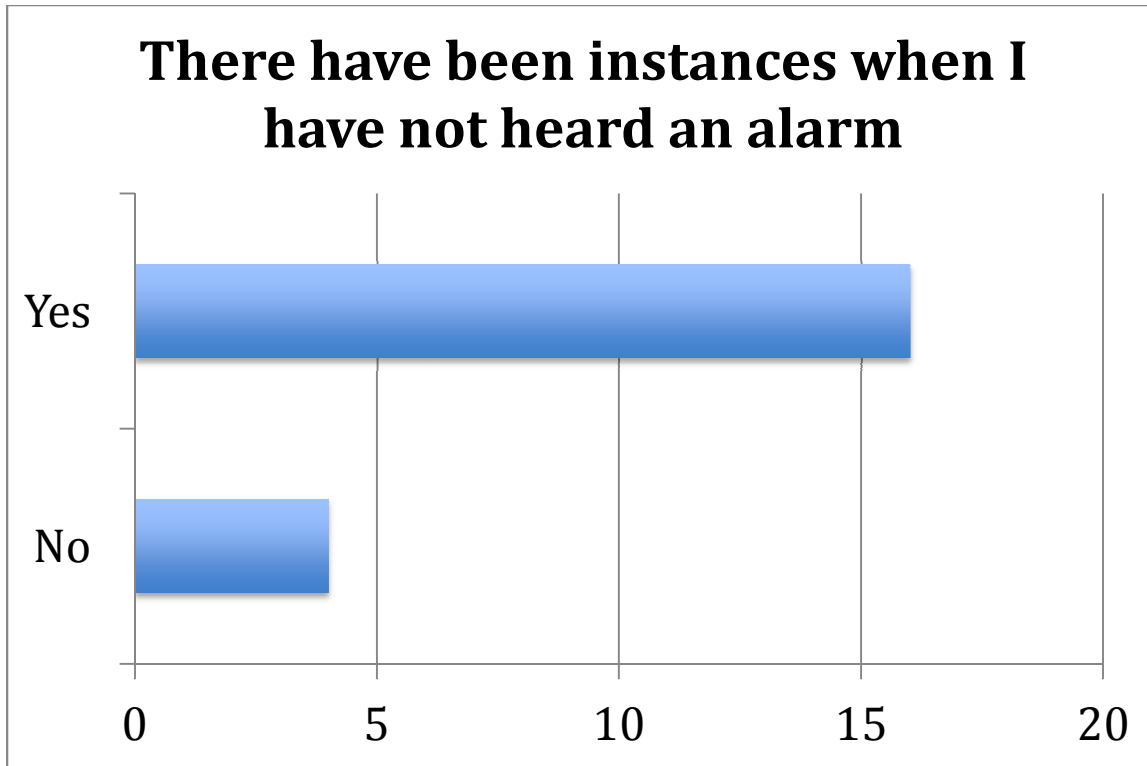
No

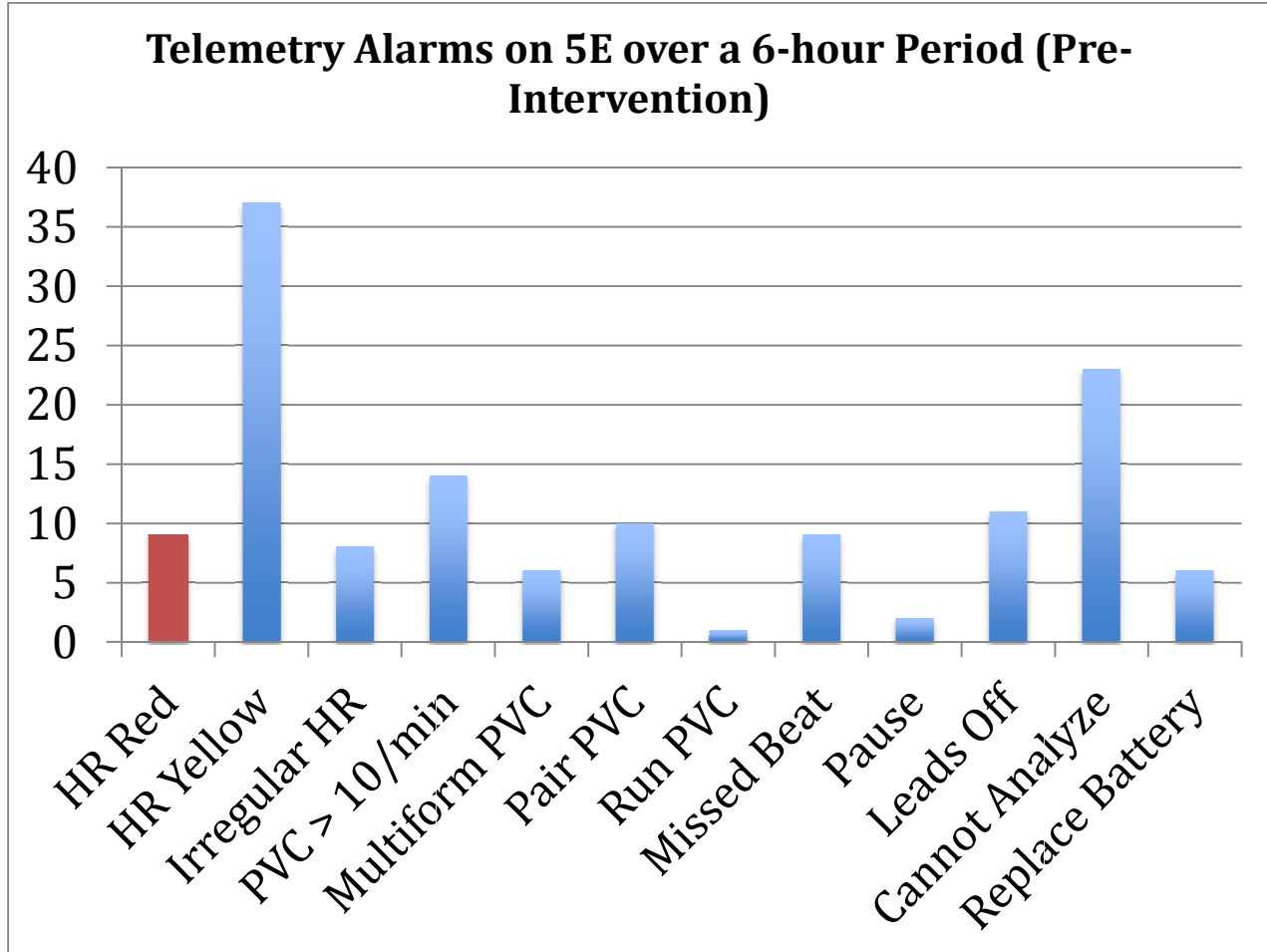
Appendix H

Baseline Data









Appendix I

Education and Communication Tool: Default Settings

| Rhythm | Current Default | New Default |
|-----------------------|----------------------------|----------------------------|
| Asystole | 4 seconds | 4 seconds |
| VTach | Rate >150 ≥ 3 PVC | Rate >150 ≥ 3 PVC |
| Non Sustained VT | On | On |
| Ventricular Rhythm | On, > 14 PVC | On, > 20 PVC |
| Run PVCs | On, > 2 | Off |
| Pair PVCs | On | Off |
| R on T PVCs | On | Off |
| Ventricular Bigeminy | On | Off |
| Ventricular Trigeminy | On | Off |
| PVCs | On, > 10/min | Off |
| Multiform PVCs | On | Off |
| Pacer Not Capture | On | Off |
| Pacer Not Pace | On | Off |
| Missed Beat | On | Off |
| Pause | 2 seconds | 2 seconds |
| SVT | On, > 150/min, ≥ 5 SVBs | On, > 150/min, ≥ 5 SVBs |
| AFib | On | On |
| Irregular HR | On | On |
| Cannot Analyze | On | On |
| Heart Rate Low | 50 | 50 |
| Heart Rate High | 120 | 120 |

Appendix J

Post-Intervention Results

