Implementing Standardized Telemetry Alarm Parameters in a Regional Hospital System

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Introduction

Problem description

Technological advances in medical equipment allow for real-time monitoring of many physiologic parameters. This commonly used equipment often utilizes clinical alarm systems comprised of auditory and/or visual notifications to alert clinicians of changes in patient condition (Hravnak et al., 2018; Phillips et al., 2020). Some equipment, like electrocardiography (ECG), also referred to as telemetry monitoring, is programmed to be highly sensitive to subtle physiologic changes requiring clinical intervention to prevent or reverse harm (Yeh et al., 2020; Yeow et al., 2018). Although research outside of critical care suggests otherwise, using continuous cardiac monitoring to alert caregivers of physiologic changes has a perceived benefit on clinical outcomes (Yeow et al., 2018).

The high sensitivity of ECG algorithms is coupled with poor specificity; therefore, monitoring results in high numbers of false-positive notifications (e.g., The monitoring algorithm identifies clinical triggers that are not present), and nonactionable "nuisance" alarms (e.g., The monitoring algorithm identifies true positives, but the change in physiological status is clinically irrelevant or untreatable) (Bi et al., 2020; Hravnak et al., 2018; Nguyen et al., 2020; Sowan & Reed, 2017; Yeh et al., 2020; Yeow et al., 2018). Alarms related to technological problems and equipment failure add to the alarm burden created by false positive, nuisance, and true alarms (Phillips et al., 2020; Yeh et al., 2020; Winters et al., 2018). One ICU-based study estimates that 89%-99% of ECG alarms are either false or nonactionable (Jepsen, 2018), while another found that only 5%-13% of alarms were both true and clinically actionable (Bi et al., 2020). Estimates

suggest that one physiologic alarm, which could be a true alarm, false positive, or nuisance alarm, occurs every 4 minutes (Koomen et al., 2021).

The underlying characteristics of alarms compromise patient safety because there is a significant risk of missed clinical instability when the few true and actionable alarms are buried within a large number of false and nuisance alarms (Hravnak et al., 2018; Nguyen et al., 2020). Adverse patient events, including death, highlight the threat of alarms to patient safety (Bi et al., 2020; Hravnak et al., 2018; Jepsen, 2018; Joint Commission (JC), 2013a; Sowan & Reed, 2017). Consequently, clinical alarms have been identified as one of the top technological hazards in healthcare since 2011 (Nguyen et al., 2020; Phillips et al., 2020; Ruppel et al., 2018). The goal to "Improve the safety of clinical alarm systems" was added as a National Patient Safety Goal for hospitals in 2014 (JC, 2013b). Hospitals were tasked with improving the safety of clinical alarm systems by identifying those alarms most critical to patient safety to manage, then developing policies and procedures to effectively manage each alarm (JC, 2013b). This led to significant efforts in research and quality improvement to improve alarm safety, but due to the complex and multifaceted nature of alarm management, these efforts failed to yield a universal solution (Phillips et al., 2020; Ruppel et al., 2018; Sowan & Reed, 2017).

This project took place at an 8-hospital system in the Pacific Northwest (PNWH). PNWH utilizes a Phillips telemetry monitor, which includes the capability for monitoring 1,216 unique physiologic parameters. This results in the potential for over 2,400 alarms from a single piece of medical equipment, in addition to the alarms from other equipment frequently used in acute care, such as IV pumps, ventilators, fall/exit alarms, and bedside capnography. Alarm parameters for PNWH telemetry monitors are not standardized between hospitals, among service areas across the region, or within service areas at each hospital. Lack of standardization creates an additional

safety risk for PNWH caregivers because there is not widespread awareness of the differences in alarm parameters between different clinical units and hospitals.

The onset of the Covid-19 pandemic in January 2020 (World Health Organization, 2020), and subsequent surges (increases in the number of cases, hospitalizations, emergency department visits, and overall utilization of healthcare resources) through 2021 coincided with this project. The novel nature of the pandemic, challenges with meeting pandemic-related demands across all systems and levels of care, the nearly constant evolution of presenting problems, and the intensity and duration of the response, were added to known alarms safety problems.

Available knowledge

Alarm safety is a complex and multifaceted problem that continues to be a significant concern in acute care settings (Ruppel et al., 2018; Sowan & Reed, 2017). The prevalence of alarm fatigue, which is desensitization to alarm stimuli, alarm apathy, and blunting of alarm responsiveness in response to long term exposure to large numbers of false and nonactionable alarms, is widespread and well documented (Bi et al., 2020; Jepsen, 2018; Nguyen et al., 2020; Ruppel et al., 2018; Sowan & Reed, 2017; Yeow et al., 2018). Research shows that alarm fatigue directly impacts patient safety through delayed or missed clinical response, the pausing or disabling of alarms, adjusting or silencing alarm volume, and inappropriately adjusting alarm parameters (Bi et al., 2020; Hravnack et al., 2018; Jepsen, 2018; Nguyen et al., 2020; Sowan & Reed, 2017; Yeh et al., 2020). The process of recognizing an alarm, evaluating the veracity of the signal, then intervening when indicated, disrupts care, erodes trust in alarms as a tool facilitating patient safety, and decreases caregiver efficiency (Hravnak et al., 2018; Nguyen et al., 2020; Ruppel et al., 2018). The response rate to clinical alarms may be impacted by alarm priority, a patient's individual alarm history (Referred to as the "Cry wolf" effect), RN past

alarm experience and overall experience, time on duty, shift duration, and change of shift. The presence of each factor, either alone or in combination, increases response time to alarms, further suggesting that the sensory overload resulting from ongoing exposure to false and nonactionable alarms only exacerbates alarm fatigue (Hravnak et al., 2018; Jepsen, 2018; Nguyen et al., 2020). While there are no qualitative and validated measures of alarm fatigue, alarm overload has been noted to increase occupational stress, decrease work performance, and negatively impact the overall wellbeing of staff (Yeh et al., 2020). The risk of the "second victim" phenomenon and collateral damage to caregiver wellbeing following patient harm due to an alarm-related event is also an important consideration (Hravnak et al., 2018).

Disagreements regarding alarm parameters and their subsequent clinical significance have hindered efforts to standardize alarms and develop protocols supporting alarm individualization based upon patient condition. Even when alarm customization protocols exist, clinicians may not understand why a change in alarm parameters could be beneficial or have the knowledge required to update the equipment settings accordingly (Phillips et al., 2020). The presence of nonactionable clinical alarms may result in overtreatment and increased resource utilization as clinicians may order additional interventions in response to alarms, regardless of clinical indication (Yeow et al., 2018). Finally, the nature and frequency of alarms may result in sleep disruption for patients, which may impact overall healing and recovery (Koomen et al., 2021; Yeh et al., 2020).

As previously described, work on alarm standardization coincided with the onset of the Covid-19 pandemic; therefore, consideration of the potential impact of Covid-19 on this work is warranted. The novel nature of Covid-19 and its unprecedented impact on every aspect of healthcare have left researchers, scholars, and medical professionals filling knowledge gaps in

real time (Denning et al., 2020; Labrague & Santos, 2021). Understanding how Covid-19

impacts healthcare workers, their practice, and patient safety has constantly evolved since the

onset of the pandemic (Arcadi et al., 2021; Kakemam et al., 2021; Norful et al., 2021). Previous

research shows that the condition of the work environment influences both patient and nurse

outcomes (Havaei et al., 2021). The Covid-19 pandemic has negatively impacted many

workplace conditions, and early research validates the associated impact on measures of

healthcare quality, including healthcare-associated infections (Galanis et al., 2021; Weiner-

Lastinger et al., 2021). Downstream effects that may be specific to alarm safety are unknown at

this time; however, one study notes that while nurses' perception of safety culture pre-pandemic

was higher compared to doctors and other clinical staff, reassessment during the pandemic found

that nurses' perception of safety culture was lower than other clinical groups (Denning et al.,

2020). This may be an important consideration for alarm standardization and management.

In healthcare, change is the routine norm rather than the exception. Change impacts

organizations, clinical practice, care delivery systems, and every space in between. Generally,

the quantity, pace, and impact of change is not well managed, which frequently results in a rapid

and unceasing flow of change. This can contribute to change fatigue in those affected (Brown &

Abuatiq, 2020). Change fatigue is described as "overwhelming feelings of stress, exhaustion and

burnout fueled by feelings of ambivalence and powerlessness associated with rapid and

continuous change in the workplace" (McMillan & Perron, 2020, p. 1). Change fatigue may add

to known and longstanding concerns regarding the presence and impact of stress, exhaustion, and

burnout in nursing, particularly in the emergency department specialty. Therefore, the

unprecedented rates of change in healthcare resulting from the Covid-19 pandemic may only

intensify the underlying workplace demands impacting the nursing workforce (Brown & Abuatiq, 2020; Galanis et al., 2021; McMillan & Perron, 2020).

Rationale

The Institute for Healthcare Improvement (IHI) Model for Improvement was used as the framework for this project. Small, rapid-cycle tests of change using a "Plan-Do-Study-Act" (PDSA) methodology guided improvement efforts (Langley et al., 2009; Provost et al., 2020). The utilization of PDSA cycles offers multidisciplinary stakeholders the opportunity to provide input and then evaluate the impact of the intervention. Building commitment through engagement in PDSA-driven improvement work will support sustaining the desired practice changes following completion of the quality improvement project.

Specific Aims

Standardize ten clinical alarm parameters on telemetry monitors at PNWH emergency departments by December, 2021.

Methods

Context

PNWH includes facilities ranging from tertiary medical centers to community and critical access hospitals. Telemetry monitors are used in the care of adult, pediatric, and neonatal patients across specialties, including emergency medicine, critical care, medical-surgical and procedural areas. Monitors utilized by anesthesia providers are outside the scope of this project. Given the range of clinical areas, stakeholders include medicine, nursing, quality, patients, and clinical engineering from each hospital facility, as well as representatives from the regional PNWH structure.

Improvement work targeting clinical alarms was initiated in late 2019 in response to a patient safety event. A narrowly scoped action plan targeting a specific gap was successfully implemented, but an expansion of the improvement program to include additional standardization across PNWH was first delayed in late 2019 following personnel changes in the department initially leading the change effort. The work was then paused by the onset of the Covid-19 pandemic in early 2020, lasting through spring 2021. PNWH is committed to patient safety and high-quality care; therefore, this work was revitalized and prioritized following the initial Covid-19 surge ending in the spring of 2021. Work was paused a second time in response to the Pacific Northwest's second significant Covid-19 surge in mid-summer 2021. In mid-fall 2021, planning to relaunch the alarm improvement work resumed, followed by a hand-off of the project to the PNWH team for implementation in spring 2022.

Intervention

The planned intervention was to identify and then implement standardized alarm parameters for telemetry monitors. Implementation of the intervention was intended to include staff education and a quality assurance process.

The first three iterations of the planning phase proceeded as intended. As Covid-19 cases began to wane in the spring of 2021, the PNWH Regional Director for Nursing Practice and Quality and author met to review and define the project scope and timeline for implementation. Evaluation of the scope and impact of the work yielded a complex and resource-intensive proposal. Input and buy-in from senior leaders and stakeholders was required to validate the scope of the work and identify the priorities for a phased implementation.

For the second planning phase in June 2021, a meeting with the PNWH Executive Director of Nursing, Regional Director of Patient Safety and Risk Management, Regional Chief

Medical Officer, and Regional Director for Nursing Practice and Quality (Regional Alarm

Steering Team (RAST)) was completed to achieve this objective. The PNWH Emergency

Departments (ED) were selected as the first clinical area to proceed with telemetry alarm

standardization. Subsequently, based on direction from RAST, a third phase of ED-specific

planning was initiated with the PNWH ED Regional Manager for Nursing Practice and Quality.

In the third phase of planning, a series of required approval points were identified based

on the ED clinical governance structure. The project could not proceed with the "do" phase of

implementation until approval was obtained at each step.

Study of the Intervention and Measures

The study of the intervention included identifying whether the approvals required by the

ED clinical governance structure to proceed with implementation were in place.

The planned measures for the original intervention were 1) the frequency of telemetry

alarms from a 3-month period prior to project launch and 2) patient safety events related to

telemetry alarms. The planned outcome measure was the number of telemetry physiologic alarm

parameters standardized.

The ability to proceed with implementation of alarm standardization requires a defined

set of physiologic parameters. The process of identifying and defining these parameters requires

resources, including the time and expertise of ED nursing leaders. Recommendations for alarm

standardization could not be drafted without their input; therefore, a series of conditions had to

be met to proceed with the process of alarm standardization. Whether these conditions were met,

either "yes" or "no," was measured. These conditions included organizational permission for

work not related to Covid-19 response, the availability of ED nursing leadership to engage in

non-Covid-19 work, the availability of ED clinical experts to engage in non-Covid-19 work, and finally, perceived staff capacity for the uptake of change impacting their clinical practice.

Analysis

A pre-defined series of conditions had to be present for the planning phase of the alarm standardization work to commence and proceed. Analysis included the presence of the condition, whether the requirements of the condition were adequately satisfied, as well as the evaluation of any new, but previously unanticipated factors that could impact planning or implementation moving forward.

Ethical Considerations

Change fatigue is a known phenomenon in healthcare that was only exacerbated by the Covid-19 pandemic (Brown & Abuatiq, 2020; Havaei et al., 2021; Labrague & Santos, 2021; McMillan & Perron, 2020; Norful et al., 2021). Change fatigue impacts the wellbeing of nurses and is also associated with adverse nurse outcomes (Havaei et al., 2021). Rapid and ongoing change may increase the pace of work, the number of hours worked, or both. The result is an "intensification" of nursing work (Willis et al., 2017). Factors such as staff skill mix and patient acuity may also contribute to the intensity of nursing work (Willis et al., 2017). Intensification may exacerbate the experience of change fatigue, decrease the quality of care and negatively impact patient safety (Magner et al., 2021; McMillan & Perron, 2020; Willis et al., 2017). The impacts of change fatigue also carry over to affect health and wellbeing outside of the work environment (Brown & Abuatiq, 2020).

The unknown nature of the Covid-19 virus necessitated frequent and often immediate changes to practice at the point of care and to the systems supporting care (Arcadi et al., 2021; Brown & Abuatiq, 2020; Drumheller et al., 2020; Fernandez et al., 2020; Havaei et al., 2021;

Norful et al., 2021; Vázquez-Calatayud et al., 2021). One nurse described the uncertain practice environment as having a "trial and error" quality (Arcadi et al., 2021). The rapid onset of the pandemic's disruption, the experience of providing care, increased acuity and complexity of care, intensification of workload, resource scarcity, the mental burden resulting from fear and uncertainty, the impact of evolving community perception and support, and significant loss of human life, coupled with the intensity and duration of these factors, have resulted in profound psychological distress and change fatigue among healthcare workers (Arcadi et al., 2021; Fernandez et al., 2020; Galanis et al., 2021; Havaei et al., 2021; Labrague & Santos, 2021; McMillan & Perron (2020); Norful et al., 2021; Weiner-Lastinger et al., 2021). Similar stressors were reported in a survey of emergency department staff (Hesselink et al., 2021). Lee et al. suggest that psychological wellbeing and coping strategies may impact safety attitudes, which in turn predict the quality of care (2019).

The nature of process improvement results in change and disruption of the status quo. Standardization of telemetry alarms in the ED will impact clinical practice, but the extent of the impact will be unknown until the standardized parameters are defined. Regardless, the disruption that even minor changes may have on the clinical practice and workflow of bedside clinicians cannot be underestimated. Implementation of alarm standardization will occur during an extended period of unprecedented change resulting from the Covid-19 pandemic. While the goal of this quality improvement project is to enhance patient safety, the project itself may actually contribute to change fatigue, which can negatively impact the quality of care. Consequently, careful consideration of resource availability, communication and education, as well as the timeline for planning and implementation will be required. Being mindful of the burden that change places on nurses and the subsequent effect that change fatigue has on outcomes, the

anticipated impact of alarm standardization on clinical practice and workflows must be thoughtfully balanced and prioritized, considering the wellbeing of caregivers as well as the demands of other concurrent PNWH and local change initiatives.

This project was determined to not be human research by the Oregon Health & Science University (OHSU) Institutional Review Board (IRB) (Appendix C: OHSU IRB Memo for STUDY00023233). The project was also determined by Providence to not meet the definition of human subjects' research and did not require IRB review (Appendix D: Providence Project Determination).

The author would like to acknowledge the support and engagement of participants from medicine, quality, nursing, and clinical engineering in this project.

Results

Results

The intent of this project was to utilize PDSA cycles to identify and refine standardized physiologic parameters for telemetry monitors in PNWH emergency departments. The onset, and subsequent resurgence, of the Covid-19 pandemic from 2020 through 2021 moved the focus of the PDSA cycles from the development and implementation of the intervention as previously described to the overall launch of the project as shown in Appendix E: Planned versus Actual Project Timeline. Consequently, the project was not implemented, and no clinical alarm parameters were standardized in the PNWH ED. Instead, disruptions resulting from the Covid-19 pandemic required multiple iterations within what would traditionally be considered the "plan" phase of the project. The presence or absence of predefined conditions necessary to proceed were evaluated (Appendix F: ED Alarm Standardization Conditions and Cycles).

Condition 1a

The first condition was organizational permission to focus resources on topics not pertaining to Covid-19. With the onset of Covid-19 in 2020, per the directive of PNWH executive leaders, all available resources were focused on patient care and the organizational response to the pandemic. Work not directly related to Covid-19 was paused until further notice. Cycles of "meeting moratoriums" and mandated resource redeployment waxed and waned in alignment with Covid-19 case counts starting in 2020 and continuing through 2021.

Cycle 1

Following Covid-19 surges in the PNWH service area in late 2020 and early 2021, Covid-19 restrictions began to ease, and limited non-Covid focused work was permitted to resume in spring 2021. Consequently, a meeting with the PNWH Regional Director for Nursing Practice and Quality was held in April 2021 to review and define the project scope and timeline for implementation. Evaluation of the scope and impact of the work yielded a complex and resource intensive proposal. Input and buy-in from senior leaders and stakeholders, the Regional Alarm Steering Team (RAST), was required to validate the scope of the work and identify the priorities for a phased implementation.

Cycle 2

Following the initial scoping and planning meeting, the RAST convened in June 2021 to review the draft proposal and provide direction regarding prioritization and phased implementation. While telemetry alarm standardization is needed in all clinical areas across PNWH, RAST decided to pilot the standardization improvement process in the ED. There were several reasons for this decision. First, the ED was already familiar with the process of alarm standardization. The steps of standardization, education, and implementation were completed for a single telemetry monitor parameter in May 2020. Second, there is not significant variability in

patient populations across the PNWH EDs; therefore, the likelihood that standardization would be impacted by variability between patient populations was reduced. Finally, the ED has a robust regional governance structure that spans all hospitals and includes medicine and nursing. Established meetings provide an efficient opportunity for consensus-building and decision-making. The overall structure facilitates moving improvement work, such as telemetry alarm standardization, forward as part of routine operations. Other clinical areas and service lines at PNWH have hospital-based leadership and governance. Gaining regional consensus will be more complex and challenging. RAST envisioned using the ED pilot to develop a framework and change management package to be used as the foundation for similar improvement in other clinical areas.

Cycle 3

Based on direction from RAST, the next planning component was a meeting with the Regional ED Manager for Nursing Practice and Quality in early July 2021. During this meeting, participants identified ED roles to be included in the alarm standardization workgroup, developed a high-level communication plan and key messages, and finalized a timeline for next steps. The resources needed to support the work, including a centralized electronic workspace, were identified. This meeting occurred during the summer vacation season, so stakeholder availability, coupled with operational cross coverage for leaders who were away, limited immediate progress on the next steps. Work was slated to resume in early August 2021 with an introduction of the project to ED providers and nurse leaders at the monthly ED Clinical Council (EDCC) meeting. In mid to late July 2021, Covid-19 cases in the PNWH service area began to rise, and at the direction of organizational leadership, non-Covid activities were again halted.

The organizational directive cancelled the EDCC as the Covid-19 surge forced the redirection of ED stakeholders and resources to pandemic response.

Condition 1b

Work unrelated to Covid-19 was stopped again in July 2021. Therefore, before focus on non-Covid-19 related topics could resume, organizational permission was required for a second time before additional planning for the standardization of ED telemetry alarms could proceed.

Cycle 4

In September 2021, Covid cases began to decrease from their August 2021 peak of 366.6 cases per 100,000 residents (Oregon Health Authority, 2020). PNWH's official organizational moratorium on non-Covid activities was still in place with an uncertain duration of continuation. Considering the impact of telemetry alarm standardization on patient safety, evaluation and follow-up was required. As Covid-19 cases decreased to approximately 260 cases per 100,000 residents, with epidemiological forecasts projecting ongoing decreases (Graven, 2021), updated direction regarding prioritization and timeline was solicited from RAST. Consequently, RAST directed telemetry alarm standardization work in the ED to continue. Permission from RAST satisfied condition 1 so the next steps could proceed.

Condition 2

The decision to resume the alarm standardization work in the ED was balanced against other clinical and organizational priorities in the context of Covid-19's ongoing impact. Leading into summer 2021, although the number of patients with Covid had decreased, the number of patients seeking care through the ED continued to increase. Increases in volume were coupled with staffing challenges as well as significant changes in the staffing mix. Large numbers of new graduate and new-to-specialty nurses, along with agency nurses, were included in staffing,

further adding to the demands on more experienced staff. This situation followed over a year of pandemic-related disruption, of which the impact on systems of care and healthcare providers is both well documented and still evolving (Weiner-Lastinger et al., 2021).

These conditions were the baseline with which PNWH's ED entered the summer 2021 Covid-19 surge. Starting in July 2021, PNWH healthcare providers and systems of care were extraordinarily taxed and drawing from a bucket of resources that was nearly, if not already, depleted. Weathering an additional wave of Covid-19 surge did not serve to restore resources or staff resiliency; therefore, the third condition focused on timing. The anticipated demands of moving toward a standardized set of telemetry alarm parameters in the ED had to be balanced against other clinical and organizational priorities in the context of Covid-19's ongoing impact.

Cycle 5

An agenda request was submitted for the EDCC meeting in October 2021. While the all-encompassing burden of the Covid-19 response had eased, the pandemic continued to significantly impact routine operations. Pent-up demand related to other clinical and practice needs had to be prioritized by the EDCC, and there were numerous agenda topics requiring emergent attention. An introduction to telemetry alarm standardization could not be accommodated. As a result, to satisfy the third conditional requirement for moving forward, the Regional ED Manager for Nursing Practice and Quality agreed to launch telemetry alarm standardization in the ED with a presentation to the ED Nursing Directors and Managers in November, 2021.

Cycle 6

The goal of meeting with the ED Nursing Directors and Managers was twofold. First, as key stakeholders for planning and implementation, this team needs to be engaged in the

improvement process as soon as possible. Their buy-in for the project's objectives, goals, and outcomes is critical to success. Second, their expertise and knowledge of current and upcoming departmental demands were needed to make recommendations regarding representation on the alarm standardization workgroup, as well as the timeline and cadence for meeting. Decisions made by the ED Nursing Directors and Managers satisfied the third condition required to move the planning phase forward to planning and operationalizing the alarm standardization workgroup.

Cycle 7

Based on feedback from ED leadership, a series of 1-hour monthly meetings were scheduled for the first quarter of 2022. The launch date and meeting cadence were validated by the Regional ED Manager for Nursing Practice and Quality (REDMNPQ) and Regional ED educators in advance to ensure the alarm standardization meetings did not directly conflict with any previously scheduled activities. The REDMNPQ sent an official solicitation for workgroup participation to ED leaders in mid-November 2021. ED leaders could opt to participate themselves, designate a clinical expert from their unit, or both. A representative from each category of PNWH EDs (tertiary medical center, community hospital, critical access hospital), along with educators and the REDMNPQ, were asked to join the workgroup for their diverse perspectives and assurance that recommendations would be inclusive of the needs of all PNWH ED practice settings.

Background information, including the ED's current alarm parameters, were prepared for dissemination to workgroup members so that synchronous meeting time could focus on validating a common understanding of the current state before proceeding with the development of recommendations for standardization. In preparing background information, the need for

support and input from stakeholders beyond nursing was clarified. Clinical engineering had been identified as a core planning and implementation stakeholder, but in this phase of planning, the need to engage the telemetry monitor vendor was also identified. The knowledge and expertise of these technical stakeholders are critical to developing a robust recommendation for standardization and will complement the clinical expertise of existing workgroup members.

Discussion

Summary

Implementation of evidence-based practice occurs at the bedside and within systems of care; therefore, it is subject to the same pressures and disruptions. Since March 2020, the Covid-19 pandemic has taxed the healthcare system and its providers in extraordinary ways, interrupted routine operations, and halted the majority of efforts not directly related to pandemic response (Denning et al., 2020; Drumheller et al., 2020; Norful et al., 2021). As PNWH emerges from the fall 2021 Covid-19 surge and attention begins to focus on the return to routine operations, including the ED telemetry alarm standardization work, the organizational and human resources required for PDSA cycles are greatly depleted. Even with compelling data and rationale to support standardization, the capacity and enthusiasm for additional change are understandably limited. Futhermore, McMillan and Perron suggest that rapid and continuous organizational change may result in apathy and nurses becoming "numb" to change (2020). Additionally, the increased pace of change, even when necessary, negatively impacts nurse wellbeing (Brown & Abuatiq, 2020; Norful et al., 2021). Opportunities to reduce workload intensity have not transpired as patient acuity, and census remained high in between Covid-19 surges (Hesselink et al., 2021). The presence of a "lull" in workload intensity is perceived as a mitigating factor for

change fatigue; therefore, the absence of a "lull" or recovery period further exacerbates change fatigue (McMillan & Perron, 2020).

Sense of duty and self-sacrifice are common themes in qualitative research focused on the experience of nurses during the Covid-19 pandemic (Arcadi et al., 2021; Fernandez et al., 2020), yet these common historical and cultural components of nursing may actually serve to contribute to feelings of burnout and change fatigue (McMillan & Perron, 2020). Additionally, Denning et al. suggest that working in conditions like those seen throughout the Covid-19 pandemic may impact staff ability to provide safe and effective care (2020). If a sense of duty and self-sacrifice are drivers for the provision of best patient care, yet the novel and dynamic nature of Covid-19's demands result in working conditions that impact quality, such as inadequate staffing, increased workload intensity, stress, and fatigue, the resulting feelings of powerlessness and loss of control will significantly impact the wellbeing of those attempting to provide care (Denning et al., 2020; Fernandez et al., 2020; Galanis et al., 2021; Hesselink et al., 2021; Labrague & Santos, 2021; Norful et al., 2021; Vázquez-Calatayud et al., 2021).

Across healthcare, the overarching impact of the pandemic on healthcare workers and the quality of care is being documented (Arcadi et al., 2021; Denning et al., 2020; Weiner-Lastinger et al., 2021). For example, 2020 data reported to the National Healthcare Safety Network showed significant increases in the number of observed to predicted infections as measured by the standardized infection ratio (SIR) for central line-associated bloodstream infection (CLABSI), catheter-associated urinary tract infection (CAUTI), ventilator-associated events (VAE) and methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia (Weiner-Lastinger et al., 2021). Additional research is needed to identify other areas where Covid-19 has impacted clinical outcomes.

The impact of the Covid-19 pandemic is not limited to frontline caregivers. Nursing leaders report experiences in common with staff, as well as experiences unique to their leadership role throughout the pandemic, including support of staff wellbeing (Vázquez-Calatayud et al., 2021). These experiences may impact how nursing leaders engage with and manage change moving forward. At PNWH, following the late summer 2021 surge, some of the changes managed by ED nursing leaders included Covid-19's ongoing impact to operations, the initiation of a delayed implementation of a telemetry monitor hardware and software upgrade, and staffing concerns related to the departure of experienced caregivers, a large influx of new graduate RNs and heavy utilization of agency staff.

Despite these challenges, work to standardize telemetry alarm parameters resumed in September 2021 and was handed off to the PNWH improvement team in early 2022 for ongoing work toward implementation. The long-term impact of Covid-19 related stress on healthcare workers is unknown (Norful et al., 2021). As understanding improves in the future, findings must be integrated into improvement plans to help reduce the burden of change fatigue on nurses and other caregivers moving forward.

Interpretation

Implementation of evidence-based practice and change management is not a linear journey. The use of PDSA cycles allows for the flexibility required to implement change in a dynamic healthcare environment. Adaptation within and between each small, rapid-cycle test of change honors the reality of process improvement at the bedside while still progressing toward improved quality and safety of care. Even when work is interrupted or delayed, the rigor of the PDSA process maintains a record of planned improvement, discoveries to date, and a framework for continuation in the future.

Quality improvement principles and the process of structured, rapid cycle change management could provide a framework for managing pandemic-related demands and disruption (Labrague & Santos, 2021; Staines et al., 2021). PDSA cycles are intended to be nimble, but the sheer volume and urgency of clinical and process changes resulting from the Covid-19 pandemic may have overwhelmed even the most efficient and effective improvement system. Regardless, Staines et al. highlight how individuals with quality improvement skills and expertise are well-positioned to support a variety of needs during a pandemic response (2021). From facilitating rapid learning cycles focused on the disease response to interventions, to promoting a culture of safety and learning, use of quality improvement knowledge and tools can provide immediate support to response efforts (Staines et al., 2021). Use of quality improvement tools and principles may also impact the ability of an organization and its staff to successfully emerge from periods of massive, rapid organizational change (Staines et al., 2021). Recognizing in advance that change fatigue in similar situations may be nearly unavoidable, developing and stress testing emergency utilization of PDSA cycles could be beneficial in future responses.

Improving understanding of how to manage the impact of organizational and clinical change is important for reducing nurse change fatigue and burnout resulting from routine operations and emergency responses. It is not clear how the extended duration of the pandemic and cycles of surge will influence the impact of interventions targeting change fatigue and burnout in the future (Magner et al., 2021; Norful et al., 2021).

Limitations

The primary limitation of this work was the inability to plan and implement as envisioned because of Covid-19. Changes to organizational processes and structure due to the pandemic necessitated revisions to the improvement plan. The resulting project focused on work-related

factors contributing to change fatigue. It does not take into consideration the many pandemic-related factors outside of the work environment that may also contribute to change fatigue (Fernandez et al., 2020; Galanis et al., 2021; Havaei et al., 2021; Labrague & Santos, 2021; Norful et al., 2021). Stakeholder engagement and the availability of resources to support improvement work may be constrained going forward. It is unclear whether the proposed plan will be transferable to PNWH clinical service lines without a centralized leadership structure, or whether similar standardization in other areas will require a different approach. Finally, unexpected challenges related to access to historical data may impact the scope of the pre-post evaluation of telemetry alarm standardization.

Conclusions

The Covid-19 pandemic has been, and continues to be, unprecedented. Regardless of its "novel" nature, Covid-19 did not create new problems in healthcare, it only exacerbated known challenges and brought their impact into sharper focus. The pace, frequency, and magnitude of change in healthcare, stemming from all conceivable sources, only seems to increase. Regardless of the intent and outcome of any change, the impact of the process of change is not benign. Change has a significant impact on nurses, both personally and professionally, which subsequently affects patient care and outcomes.

The response to the Covid-19 pandemic halted many non-Covid related quality improvement efforts. As healthcare moves into the next phase of the pandemic and "new normal," for the foreseeable future, any change and return to routine improvement will be added to an underlying baseline of ongoing Covid-19 management. The stops and starts described in the course of the ED telemetry alarm standardization project serve as an exemplar of the all-consuming nature of the pandemic response, and highlight challenges that may be faced as

healthcare systems and processes transition from acute to essentially chronic Covid-19 management.

Additional study regarding how to plan and implement change in a sustainable manner with manageable impact is needed. This gap existed before Covid-19, so the effects of the pandemic now provide an additional consideration for research. Evidence-based strategies for the prevention and management of change fatigue also need to be expanded.

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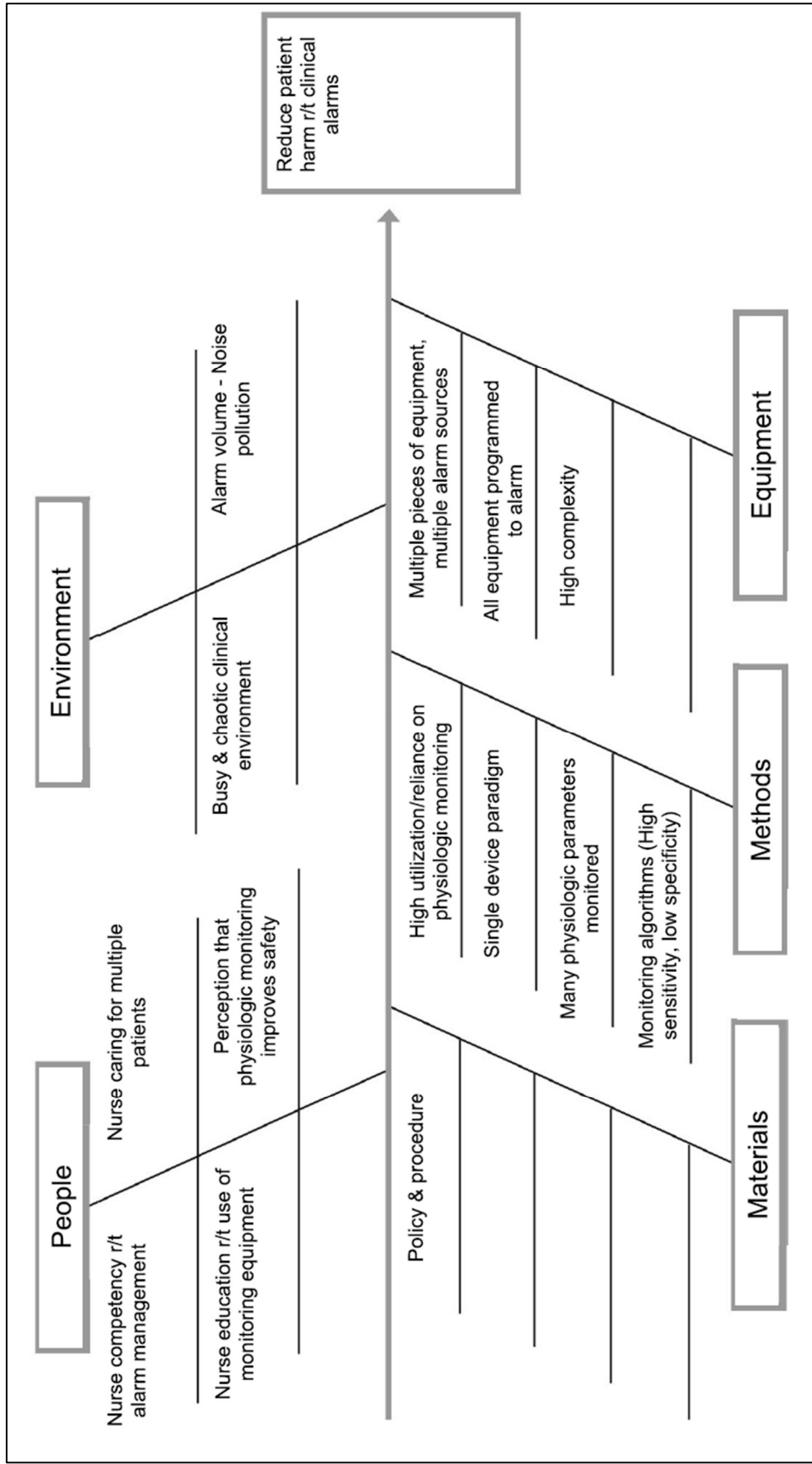
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Appendix A

Clinical Alarm Standardization Cause and Effect Diagram

Appendix B

Letter of Support From Project Implementation Site

Date: 05/17/2021

Dear Marisa Gillaspie Aziz,

This letter confirms that I, Mary J. Waldo, allow Marisa Gillaspie Aziz (OHSU Doctor of Nursing Practice Student) access to complete her DNP Final Project at our clinical site. The project will take place from approximately 06/01/2021 to 12/15/2021.

This letter summarizes the core elements of the project proposal, already reviewed by the DNP Project Preceptor and clinical liaison (if applicable):

Project Site(s): Providence Health & Services, 4400 NE Halsey St., Portland, OR 97213

Project Plan

Lack of standardization in telemetry alarms has resulted in patient safety events at Providence Health and Services (PHS). Evidence suggest that standardization of telemetry alarms can improve patient safety. The Institute for Healthcare Improvement's Model for Improvement will be used as the framework for this project. It is expected that several cycles of change (PDCA cycles) will be required to achieve balance between alarm sensitivity and specificity resulting in improved patient safety and reductions in alarm fatigue. Consequently, the aim of this project is to standardize 10 clinical alarm parameters on telemetry monitors at PHS by December, 2021. To achieve this aim, alarm data will be analyzed using frameworks described in the literature, then multidisciplinary stakeholders will determine a set of standardized alarm parameters for implementation. Patient safety events before and after the implementation of updated alarm parameters will be evaluated. Alarm data will be deidentified while safety events will remain identifiable. All project data will be accessed and stored on the password protected and secured PHS network. The student may utilize applicable PHS data, contact and engage with appropriate stakeholders, and collaborate with impacted clinical areas to develop and implement this project. Additional site supports will be reviewed and approved by DNP Project Preceptor as needed.

During the project implementation and evaluation, Marisa Gillaspie Aziz will provide regular updates and communicate any necessary changes to the DNP Project Preceptor.

Our organization looks forward to working with this student to complete their DNP project. If we have any concerns related to this project, we will contact Marisa Gillaspie Aziz and Dr. Doria K. Thiele (student's DNP Project Chairperson).

Regards,

Dr. Mary J. Waldo	Regional Director
PhD, RN, GCNS-BC, CPHQ	Professional Practice, Quality and Research
DNP Project Preceptor	Job Title
Mary Waldo	5-18-21
Signature	Date Signed

Appendix C

Oregon Health & Science University IRB Determination

OHSU logo — Oregon Health & Science University / IRB MEMO / Research Integrity Office / 3181 SW Sam Jackson Park Road - L106RI / Portland, OR 97239-3098 / (503)494-7887   irb@ohsu.edu

NOT HUMAN RESEARCH

July 6, 2021

Dear Investigator:

On 7/6/2021, the IRB reviewed the following submission:

Title of Study:	Implementing Standardized Telemetry Alarm Parameters in a Regional Hospital System
Investigator:	Doria Thiele
IRB ID:	STUDY00023233
Funding:	None

The IRB determined that the proposed activity is not research involving human subjects. IRB review and approval is not required.

Certain changes to the research plan may affect this determination. Contact the IRB Office if your project changes and you have questions regarding the need for IRB oversight.

If this project involves the collection, use, or disclosure of Protected Health Information (PHI), you must comply with all applicable requirements under HIPAA. See the HIPAA and Research website and the Information Privacy and Security website for more information.

Sincerely,

The OHSU IRB Office

Appendix D

Providence Project Determination

✚ Providence

PROJECT DETERMINATION

Date:	June 11, 2021
To:	Marisa Gillaspie Aziz, MSN, RN, ACNS-BC gillaspm@ohsu.edu marisa.gillaspieaziz@providence.org
Cc:	Mary Waldo, PhD, RN, GCNS-BC, CPHQ mary.waldo@providence.org Doria K. Thiele, PhD, CNM, IBCLC thiele@ohsu.edu
From:	Madeliene Carlos, CIM, CIP Manager, Behavioral and Minimal Risk Panel
Project Title:	"Standardizing Telemetry Alarm Parameters in a Regional Hospital System: A Quality Improvement Project"

This represents the IRB determination for the above referenced project.

The IRB has determined that this project, as submitted, does not meet the definition of human subjects' research and does not require IRB review as defined in the federal regulations.

The determination is based upon the information submitted only, revisions must be submitted to the IRB prior to implementation.

This determination does not exempt you from following hospital policies and procedures as they relate to conduct of this project. It is your responsibility to ensure compliance with those policies.

If you have questions related to this determination, please contact:
Madeliene Carlos, CIM, CIP | Manager, Behavioral and Minimal Risk Panel
Madeliene.Carlos@providence.org

If you have questions related to QI/PI/EBP review, please contact us at:
PSJHIRBDetermination@providence.org

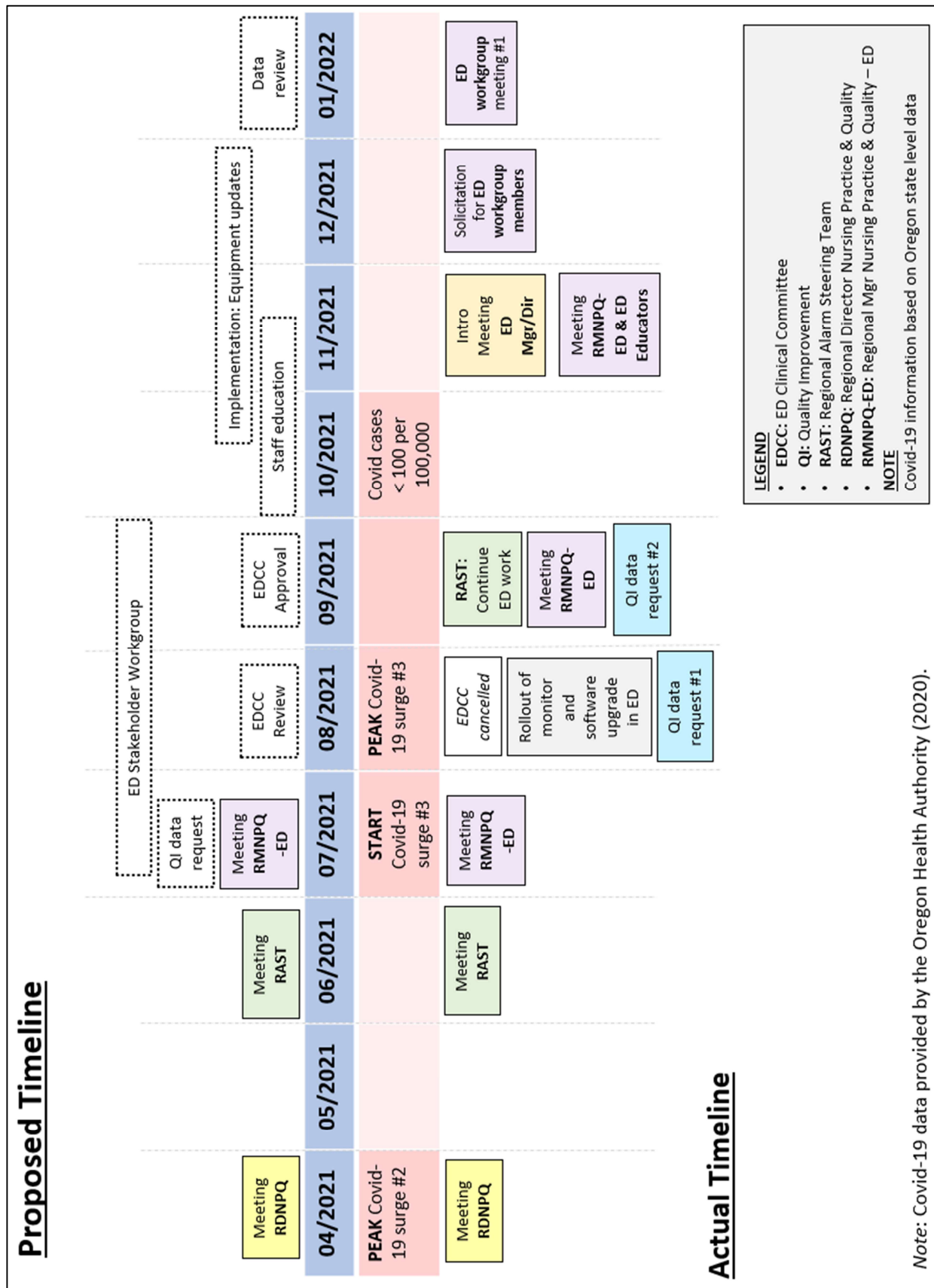**Project Leads/Student Faculty-Advisors/Providence Sponsors must comply with all the following:**

➢ Conduct your project in accordance with the information submitted to and reviewed by the IRB.

➢ All revisions to this project must be submitted to the IRB prior to implementation.

➢ Students **cannot** directly access any Protected Health Information (PHI) through Epic or any other database, this must be completed by the Providence Sponsor.

➢ All PHI and confidential PSJH information must remain on a PSJH campus and on a PSJH secure computer.
  o PHI and confidential PSJH information must not be recorded on personal computers or other electronic devices including USBs, smartphone (including taking pictures of data), emailing information to a personal e-mail account.
  o Paper copies of PHI cannot leave the PSJH facility.

➢ Project results that leave PSJH for inclusion in a poster/paper presentation/publication must be in aggregate (summary statistics) form only and/or be de-identified. There must be no way to link the data to a patient, either alone or in combination with other information.

➢ Failure to comply with PSJH integrity, compliance, privacy and security standards and requirements will result in appropriate corrective action.

➢ This project may be audited.

PHI Includes:

1) Names
2) All geographical subdivisions smaller than a State, including street address, city, county, precinct, zip code, and their equivalent geocodes, except for the initial three digits of a zip code, if according to the current publicly available data from the Bureau of the Census: (1) The geographic unit formed by combining all zip codes with the same three initial digits contains more than 20,000 people; and (2) The initial three digits of a zip code for all such geographic units containing 20,000 or fewer people is changed to 000
3) All elements of dates (except year) for dates directly related to an individual, including birth date, admission date, discharge date, date of death; and all ages over 89 and all elements of dates (including year) indicative of such age, except that such ages and elements may be aggregated into a single category of age 90 or older
4) Phone numbers
5) Fax numbers
6) Electronic mail addresses
7) Social Security numbers
8) Medical record numbers
9) Health plan beneficiary numbers
10) Account numbers
11) Certificate/license numbers
12) Vehicle identifiers and serial numbers, including license plate numbers
13) Device identifiers and serial numbers
14) Web Universal Resource Locators (URLs)
15) Internet Protocol (IP) address numbers
16) Biometric identifiers, including finger and voice prints
17) Full face photographic images and any comparable images; and
18) Any other unique identifying number, characteristic, or code (note this does not mean the unique code assigned by the investigator to code the data)

Appendix E

Proposed versus Actual Implementation Timeline for Telemetry Alarm Standardization in ED

Proposed Timeline

04/2021	05/2021	06/2021	07/2021	08/2021	09/2021	10/2021	11/2021	12/2021	01/2022
Meeting RDNPQ		Meeting RAST	Meeting RMNPQ-ED / QI data request	EDCC Review	EDCC Approval	Staff education	Implementation: Equipment updates		Data review
			ED Stakeholder Workgroup						

PEAK Covid-19 surge #2 — START Covid-19 surge #3 — PEAK Covid-19 surge #3 — Covid cases < 100 per 100,000

Actual Timeline

04/2021	06/2021	07/2021	08/2021	09/2021	11/2021	12/2021	01/2022
Meeting RDNPQ	Meeting RAST	Meeting RMNPQ-ED	*EDCC cancelled*	RAST: Continue ED work	Intro Meeting ED Mgr/Dir	Solicitation for ED workgroup members	ED workgroup meeting #1
			Rollout of monitor and software upgrade in ED	Meeting RMNPQ-ED	Meeting RMNPQ-ED & ED Educators		
			QI data request #1	QI data request #2			

LEGEND
- **EDCC**: ED Clinical Committee
- **QI**: Quality Improvement
- **RAST**: Regional Alarm Steering Team
- **RDNPQ**: Regional Director Nursing Practice & Quality
- **RMNPQ-ED**: Regional Mgr Nursing Practice & Quality – ED

NOTE
Covid-19 information based on Oregon state level data

Note: Covid-19 data provided by the Oregon Health Authority (2020).

Appendix F

ED Alarm Standardization Conditions and Cycles