Title
Telemetry: Less is More. The Application of Practice Standards to Electrocardiographic Monitoring of Surgical Patients

Author
Le Huquet, Cheryl Diane

Publication Date
2020

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA

Los Angeles

Telemetry: Less is More. Application of Practice Standards to Electrocardiographic Monitoring of Surgical Patients

A dissertation submitted in partial satisfaction of the

requirements for the degree

Doctor of Nursing Practice

by

Cheryl Diane Le Huquet

2020

ABSTRACT OF THE DISSERTATION

Telemetry: Less is More. The Application of Practice Standards to Electrocardiographic Monitoring of Surgical Patients

by

Cheryl Diane Le Huquet

Doctor of Nursing Practice

University of California, Los Angeles, 2020

Professor Lynn V. Doering, Chair

Background: Effective utilization of resources and attention to a healthy work environment are at the forefront of nursing leadership agendas. The practice of telemetry stewardship supports a healing environment for patients and reduces alarm burden on staff. The literature is replete with studies in medical units regarding reduction of alarm burden using telemetry stewardship. However, there are no existing, prospective studies addressing the impact of telemetry utilization on alarms in surgical units. **Objectives**: This quality improvement (QI) project applied the best available evidence and provider preference to encourage telemetry stewardship and identified the associated impacts of appropriate telemetry monitoring on patients and staff. The unintended consequences of overuse of electrocardiographic (ECG) monitoring in the project unit included interruptions to care and alarm fatigue for patients and staff. **Methods:** A nurse-led interdisciplinary evidence-based QI project based on the 2017 American Heart Association (AHA) revised practice standards (Sandau et al., 2017) was implemented over ten weeks in a surgical unit in an academic medical center. Pre and post educational intervention aggregate data was obtained from the electronic health record (EHR) and standard reports. Perception of alarm fatigue and baseline adoption of standard practices were obtained using a nationally recognized survey. **Results:** The percentage of patients on the monitor did not change in response to the intervention (p = .12), and there was no significant reduction in alarms per patient per day (p = .07). Results of the perception of alarm fatigue survey, while not clinically significant (p = .56), provided a baseline for the scholarly project and future QI projects. There was no increase in adverse patient events during the project. **Conclusion:** A nurse led interdisciplinary strategy using the AHA revised practice standards can be safely applied to a complex surgical population to create a common platform to address the burden of inappropriate telemetry monitoring on patients and staff.

Keywords: telemetry, stewardship, nurse-led, evidence-based, quality improvement, practice standard

The dissertation of Cheryl Diane Le Huquet is approved.

Mary Ann Lewis

Su Yon Jung

Christine Samuel-Nakamura

Lynn V. Doering, Committee Chair

University of California, Los Angeles

2020

Dedication

With extreme pride, I dedicate this work to my parents, Kay and Al Le Huquet. Your unconditional love, understanding, and support were the foundation for this accomplishment.

"I did then what I knew best, when I knew better, I did better" Maya Angelou

Table of Contents

List of Tables

Acknowledgements

The UCLA School of Nursing has been my academic home for over a decade. I would like to recognize two academic nurse leaders who have guided my path and held the bar high every step of the way from my first day of class to my final approval. Dr. Mary Ann Lewis was my first professor at the school of nursing. Her knowledge, excellence and grace have provided a bar to which I have strived to achieve throughout my career. I was thrilled to have Dr Lewis as a committee member, providing thoughtful guidance and a gentle push to dig deeper and expand my scholarship.

Dr. Suzette Cardin was the Assistant Dean of Student Affairs when I began the Bridge program. She recognized my leadership and scholarship long before I did, and I have appreciated her guidance and support along this journey through to the completion of my terminal degree. Thank you for your patience, leadership and modeling the way in the development and support of the first DNP program at the UCLA SON.

Dr. Bush, I cannot thank you enough for your kindness, flexibility and unwavering advocacy for the first cohort of the DNP program. You were our rock and a safe place when things were not going as anyone expected. Your calm guidance and determination guided us every step of the way.

To my committee who persevered through tight timelines and uncertainty under the guidance of my Chair Dr Doering, thank you! The first cohort blazed the way, but I could not have been successful without each of your support, attention to detail and willingness to embrace the DNP program and its role in advancing nursing science. Dr Jung, your statistical excellence and questions encouraged me to see my data in new ways, and Dr. Samuel-Nakamura, your keen eye when I couldn't see the forest for the trees strengthened my writing and encouraged me to think differently. And finally, guiding my journey and the path of DNP class of 2020, Dr. Doering. Thank you for your leadership and flexibility as we navigated uncharted waters.

At a hospital level, I would like to thank the unit leadership and nursing staff for embracing EBP and challenging the status quo to advocate for their practice and for the patient experience. Thank you to my DNP mentor, Raquel Branom, who challenged every framework and assumption with a smile. Your passion and joy for the DNP process kept me afloat during times of uncertainty and your open door was a haven and a safe place to express my assumptions and question virtually everything.

And finally, to my family, friends who are family and my long-suffering boyfriend who understood my absences and continued to invite me to events and call and text despite very delayed responses from me. You were my lifeline to the world beyond academia and without you encouraging me to continue to take breaks and restore myself in nature, I would not have been as successful. Academia was the original social distancing, and I am looking to resuming our relationships, even in a modified fashion.

VITA

Education

1987	Nursing Diploma Vancouver General Hospital School of Nursing Vancouver, British Columbia, Canada
1990	Certificate of Critical Care Nursing British Columbia Institute of Technology Burnaby, B.C., Canada
2008	Baccalaureate of Science University of California, Los Angeles School of Nursing Los Angeles, California
2010	Masters of Science in Nursing (Nursing Administration) University of California, Los Angeles School of Nursing Los Angeles, California

Presentations

Telemetry: Less is More. Application of Practice Standards to Electrocardiographic Monitoring of Surgical Patients. **Poster:** UCLA School of Nursing Research Days: 2020, May 6.

Application of Practice Standards to Electrocardiographic Monitoring in Surgical Patients. **Poster:** Western Institute of Nursing's 53rd Annual Research Conference: 2020, April 6.

Aoki K, Dermenchyan A, Exarchos N, LeHuquet **C**, Luistro E. Yo Entiendo: I Understand. **Podium Presentation:** Western Institute of Nursing's 49th Annual Communicating Nursing Research Conference; 2016, April 7-9; Anaheim, CA

Reducing Hospital Readmissions: Patient Experience in Transition of Care Eslami, Michelle, Lee, Gwendolyn, Le Huquet, Cheryl**. Poster:** DGSOM UCLA Department of Medicine Research Day, 2015

Communicating the Vision for Performance Excellence. **Presentation**. UCLA School of Nursing, Los Angeles, California: 2012, August

Vasoactive Infusions in the Neonate, Third Annual Neonatal Nursing Conference, **Podium Presentation** Deenanath Mangeshkar Hospital, Pune, India. 2004, September

Awards

Dr. Suzette Cardin Scholarship for Academic Excellence, 2019
UCLA Health. Strategic Excellence Award. June 2018

Chapter One

The phenomenon of interest for the Doctor of Nursing Practice (DNP) scholarly project is the overuse of technology in a healthcare environment where the Quadruple Aim is utilized as a framework for decision making (Bodenheimer & Sinsky, 2014). The Institute for Healthcare Improvement (IHI) describes the four foundational aims of quality improvement efforts in healthcare as: patient-centric, cost-effective, population-focused, and supportive of workplace satisfaction (Institute for Healthcare Improvement [IHI], 2020). Health technology assessment includes the evaluation of technologies to solve health problems and improve quality of life as well as the appraisal of direct and indirect consequences (World Health Organization [WHO], 2019).

Telemetry, an early technological tool in the care of hospitalized patients, is an automated communications process by which measurements and other data are collected at remote or inaccessible points and transmitted to receiving equipment for monitoring. The word has Greek roots; tele meaning remote, and metron meaning measure ("Telemetry", 2019). Telemetry monitoring is ubiquitous in medical surgical units across the nation, despite the establishment of recognized practice standards that identify appropriate use cases, duration for monitoring, and situations where ongoing monitoring may be harmful (Sandau et al., 2017). In fact, inappropriate telemetry monitoring has been implicated as a root cause of alarm fatigue, a national patient safety issue (The Joint Commission [TJC], 2013). Other research suggest that inappropriate telemetry monitoring may also increase the cost of care, length of stay, and patient and staff satisfaction in inpatient units (Bulger et al., 2013; Chong-Yik et al., 2018; Dressler et al., 2014; Falun et al., 2013; Patel et al., 2016; Svec et al., 2015).

Problem Statement

The use of telemetry in acute care hospitals is not benign. On the contrary, telemetry monitors, and the requisite alarms and alerts, contribute to alarm fatigue, a complex concern for patients and staff.

Clinical Question

While there is a use case for applying the revised AHA practice standards (2017) in surgical non-intensive care units (ICU), there is a paucity of evidence demonstrating the application of the practice standards to this population. The PICOT question for this DNP scholarly project is: For surgical patients in an academic medical center (P), does a nurse-led interdisciplinary strategy based upon the revised AHA practice standards (I) compared to a decision support prompt in the electronic health record (EHR) (C) reduce the number of inappropriately monitored patients (O) over a ten week pilot period (T)?

Purpose and Objectives

Despite the availability of consensus statements describing the best evidence in support of telemetry monitoring, unnecessary monitoring continues in inpatient areas. The purpose of this evidence-based quality improvement (EBP QI) project was to reduce inappropriate telemetry monitoring in a surgical unit in a large academic medical center.

Background

Telemetry, first designed in 1949, became popular as the nation watched the heart rates of the astronauts in the live screening of the first spacewalk (Durban, 2016). The technology was adopted by anesthesiologists and spread to ICUs as a standard of practice over the subsequent decades. As the technology expanded beyond critical care areas, the American College of Cardiology (ACC) determined that, without boundaries, telemetry may be overused (Schlant et al., 1992). As telemetry use increased, the AHA commissioned an interdisciplinary team to assess the state of the science and develop a practice standard (Drew et al., 2004). As the technology for telemetry monitoring became a standard of practice in medical surgical units, the AHA revisited the science and commissioned the most recent revised practice standards (Sandau et al., 2017). The 2017 revised practice standards, endorsed by nursing and physician practice associations, are considered the best evidence in support of utilizing continuous ECG monitoring in an inpatient setting.

Chapter Two: Conceptual and Theoretical Frameworks

Implementation of successful EBP QI projects in a surgical unit in an academic medical center can be daunting. Careful consideration of the system mission, vision, values, and nursing frameworks provide guidance to project development and implementation. The purpose of this chapter is to describe the conceptual and theoretical frameworks that supported this project.

Concepts

Healthcare, a uniquely complex system, requires highly engaged and interdependent teams of healthcare providers to execute the right care at the right time while using the right resources to improve patient outcomes (IHI, 2020). The IHI amended the Triple Aim to address staff satisfaction as care team burnout and workplace dissatisfaction were identified as barriers to providing highly reliable processes and safe patient care (Bodenheimer & Sinsky, 2014; CareerBuilder, 2013). Under the IHI framework, quality and process improvement in healthcare shifted from care of the sick to prevention and support of wellness, providing opportunities to reassess existing practices (Strout, 2012).

Frameworks

The frameworks applied to understand the phenomenon of inappropriate telemetry monitoring in a surgical unit in an academic medical center included a nursing theory, a research utilization strategy, and an educational framework.

Nursing Framework

Neuman's System Theory, a grand nursing theory, supports the open systems that engage regularly with the environment. Neuman acknowledged the individual stressors and compensatory factors in a healthcare environment that impact patient outcomes (Neuman, 1982).(See Appendix A). The pilot unit recently increased telemetry capacity by 60 percent by installing a physiologic monitor in every room. In the absence of processes to identify patients not requiring monitoring, there was a 40 percent increase in telemetry monitoring. The concomitant burden of increased noise levels in the unit and disruptions to staff workflows to address alarms resulted in patient and staff dissatisfaction. Alarm burden, a national safety concern for staff, also negatively impacts rest and recovery in post-surgical patients. Neuman's theoretical model aligned with the vision of the practice setting and supported the nursing strategic goal of developing systems to address wellness in staff, patients and families (Grimley & Branom, 2019).

Research Utilization Framework

Application of best practices and the most recent evidence in a complex environment required a focused approach. The Stetler Model for Research Utilization (2001) provided a clinician-centric conceptual framework to guide application of research to the bedside to improve outcomes by addressing both the research and implementation science required to adopt EBP (See Appendix B). Stetler (2001) acknowledged expert opinion as the best available external evidence for phenomena that are not amenable to randomized control studies, and addressed the critical roles of context, culture, time constraints, and past experiences in the adoption of research into practice. The pilot unit had adopted several best practices including daily bedside rounds with the care team, patient and family. Prior to the telemetry expansion, daily discussions about need for telemetry monitoring were determined by the number of monitors available and limitations to throughput. With the increase in monitoring capacity, the discussions ceased. This project acknowledged the historical context of telemetry monitoring in the unit and capitalized on existing best practices to support a successful implementation.

Educational Framework

A multidisciplinary educational intervention required careful consideration of timing and impacts to the practice of each of the healthcare team members. Adult learning theory was used to develop the educational materials and delivery strategies for this project (Knowles, 1978). Although the practice standard has been available for 15 years, it was new to the surgical team members. Recognizing the drivers for each group in the care team and the existing methods of just-in-time education were essential to the development of the pre-intervention educational materials and timelines. Knowles identified timeliness and clear articulation of the rationale as essential to application of new knowledge and behavioral change in adult learners.

A successful EBP QI project was supported by the integration of the conceptual and theoretical frameworks. These underpinnings provided a systematic approach to change and guided the search for the best evidence in support of telemetry stewardship.

Chapter Three: Review of the Literature

Telemetry monitoring is ubiquitous in medical surgical units and has become synonymous with a basic standard of care. As use of telemetry spread from operating theaters and ICUs to medical surgical units, nursing and physician leaders cautioned about the perils of inappropriate telemetry use. The purpose of this chapter is to explore the literature to identify the best evidence in support of telemetry stewardship.

Literature Search

A comprehensive literature search was performed in support of the PICOT question using PubMed, Cumulative Index of Nursing and Allied Health Literature Plus (CINAHL Plus), and Google Scholar, and the search terms telemetry, inappropriate, American Heart Association, and quality. A search filter of ten years and English language only, revealed 768 publications, including peer-reviewed studies, practice standards, published protocols, published posters, presentations from conferences, and published DNP scholarly projects. Twenty-five publications were selected based upon research design, outcomes of interest, like settings, and the application of either the 2004 or 2017 AHA practice standards.

Synthesis of the Literature

Telemetry monitors, once reserved for critical care setting, have become accepted as the standard of care in medical surgical units (Cvach, 2012). The AHA revised practice standards provide the best evidence for appropriate telemetry monitoring, informing healthcare decision making and reducing potential harm to patients and staff (Emergency Care Research Institute [ECRI], 2014; The Joint Commission [TJC], 2013). In the scientific and clinical literature, nurses and physicians have addressed inappropriate telemetry monitoring, but rarely in a collaborative manner.

The American Board of Internal Medicine listed inappropriate telemetry monitoring as one of the top five opportunities to reduce waste in healthcare in their Choosing Wisely campaign (Bulger et al., 2013). This call to action resulted in many physician-led initiatives from physician education to revision of order sets. Outcome measures included length of stay, reduction of extraneous tests, cost savings, and utilization management (Benjamin et al., 2013; Chen et al., 2017; Chong-Yik et al., 2018; Drew et al., 2004: Ivanye et al., 2010; Najafi et al, 2019; Potluri et al., 2017; Schachter & Gopalakrishnan, 2019; Stolzfus et al., 2019). Many of the early studies were retrospective reviews, focused on determining the ordering behaviors of providers, compliance to 2004 AHA practice standards, and possible harm to patients (Chen et al., 2017; Chong-Yik et al., 2018; Ivanye et al., 2010).

Among the prospective studies, several relied heavily upon modification of EHR order sets (Alsaad et al., 2017; Dressler et al., 2014; Edholm et al., 2018; Najafi et al., 2019; Rayo et al., 2015; Schachter & Gopalakrishnan, 2019). There was also evidence of successful educational interventions for physicians only (Patel et al., 2017; Potluri et al., 2017; Svec et al., 2015), however, some researchers have demonstrated that educational interventions alone may not be effective to facilitate the timely adoption of practice standards (Brug,et al., 2018; Cabana et al., 1999).

Three physician-led studies reported collaboration with nurses to develop and implement a nursing protocol to prompt the physicians to discontinue telemetry (Alsaad et al., 2017; Rayo et al., 2015; Schachter & Gopalakrishnan, 2019).

In contrast to physician-led studies, those studies in which nurses and physicians worked together to develop and implement EBP QI projects yielded better patient and staff satisfaction outcomes. The results demonstrated the impact of the reduction of inappropriate telemetry monitoring on the perception of alarm fatigue and disruptions to workflow, as well as the effect of the efficient utilization of resources on improving throughput (Allan, 2018; Bubb, 2011; Funk et al., 2018; Lewis & Oster, 2019; Perrin et al., 2016). One retrospective nursing study reviewed the appropriateness of telemetry ordering patterns in a medical unit (Phillips et al., 2019), while another described the impact of a standardized admissions order set on physician ordering behavior in all admissions to medical surgical telemetry beds (Sendelbach et al., 2019). The remainder of nursing studies used the 2004 or 2017 AHA Practice Standards as the basis for educational interventions and development of nurse-led protocols. To date, no studies have focused primarily upon surgical units.

In both nurse and physician-led studies, investigators recognized a knowledge deficit regarding the AHA practice standards. Interventions incorporating use of standardized order sets (Dressler et al., 2104; Schachter & Gopalakrishnan, 2019) and interventions including physician education alone were less effective than interdisciplinary approaches led or supported by nurses (Perrin et al., 2016; Zadvinskis et al., 2018). Strong leadership support was recognized as an essential component of a successful strategy to support the adoption of the AHA practice standards in all studies (See Appendix C).

A review of the literature from the past decade identified several studies that utilized the AHA Practice Standards for ECG Monitoring (2004) to address waste in healthcare and the impact on patients and nursing staff. Notwithstanding, telemetry overuse in medical surgical units remains widespread.

Summary of the Literature

Over the past decade, many studies addressing the impact of inappropriate telemetry monitoring in non-ICU settings have been published. Application of the AHA revised practice standards are limited in the literature, but there are many physician and nurse-authored studies that have determined that the 2004 AHA practice standards can be adopted safely in medical surgical units. Careful consideration of the practice setting and the drivers for change, including system goals and established frameworks, guide successful project planning and implementation. And finally, nurse led interdisciplinary EBP QI projects with strong leadership support have proven to be effective in supporting telemetry stewardship.

Chapter Four: Methods

This EBP QI project applied the best evidence to the complex phenomenon of telemetry overuse in a surgical unit in an academic medical center. The interdisciplinary educational intervention addressed the concerns of each team member while keeping patient safety as a primary outcome measure. The purpose of this chapter is to discuss the project design and implementation strategy.

Ethics/ Institutional Review Board Statement

The educational intervention, Healthcare Technology Foundation (HTF) Clinical Alarm Survey, and project plan were approved by the Institutional Review Board (IRB) and facility EBP council as a quality improvement project (See Appendix D).

Project Design

The scholarly project was a repeated measures educational intervention project consisting of 15-minute in-person group educational sessions based upon the 2017 AHA revised practice standards. Single page reference tools were adapted from the AHA revised practice standards and reviewed by an institutional expert before implementation (See Appendix E and F).

Setting

The setting for this project was a 26-bed surgical unit that is representative of the acute care surgical units at the academic medical center. The average length of stay on this unit is five days and the average occupancy is 96 percent. The unit received an average of three new patients from the perioperative recovery room or ICU daily Monday to Friday, of which more than 90 percent were monitored. The scholarly project included more than 140 individual patients over the course of the ten-week implementation period between February 1, 2020 and April 11, 2020. The patient population included 18 unique surgical service lines, including general surgery, gender reassignment, head and neck, oncology, and kidney transplant.

The pilot unit was supported by a traditional academic institutional model with a dedicated team of nursing staff, rotating teams of surgeons, and residents. The nursing staff of the pilot unit included registered nurses (RNs) (70%) and licensed vocational nurses (LVNs) (10%), supported by certified nurse assistants (20%) (Department of Nursing UCLA Health, 2018). Each surgical team had at least one Advanced Practice Nurse (APRN) who worked with the surgical team and had joint responsibility for order management with the residents and interns. The surgical residents and interns rotated every three to four weeks, while the APRNs remained dedicated to their respective teams.

Sampling

Telemetry, for the purpose of this project, was defined as continuous ECG monitoring. This definition excluded patients with continuous pulse oximetry only as that monitoring parameter was not included in the AHA practice standards. The sampling strategy for the scholarly project was a convenience sample of all patients with orders for continuous ECG monitoring during their stay on the pilot unit. The intervention was applied daily to all patients with active ECG monitoring orders.

The project population was limited by the census on the pilot unit. The robust surgical schedule and volume of surgical patients limited the number of non-surgical patients on the project unit. Historically, capacity and throughput issues necessitated placement of medicine patients on the surgical floor. Medicine patients were not included in the nurse-led protocol, and the medicine provider teams did not receive the same education as their surgical counterparts. Patient attribution was determined by team and attending physicians listed in the EHR. The primary surgical services associated with the units were: Trauma, Thoracic, Vascular, Plastics, Liver/ Transplant, Urology, Urology Transplant, Gastroenterology, and Surgical Oncology (Pancreas and Sarcoma). Specialty services included Bariatric, Gynecology, Gynecology Oncology, Breast, Orthopedics and Endocrine.

Implementation Process

Standardized education was foundational for the intervention, and a total of 114 providers and 56 members of the nursing team, were educated in person prior to the project launch. The 15-minute education sessions for nursing staff and surgical providers were conducted over a three-week period using existing scheduled meetings.

Engagement of the Surgical Team

The provider education was presented at the Department of General Surgery morbidity and mortality rounds, attended by 89 attending physicians, residents and interns. The investigator shared the same presentation with the APRNs during the quarterly APRN meeting, which was attended by 25 people.

Engagement of Leadership

The Chief Nurse Executive (CNE) and Chief Medical Officer (CMO) approved the project design and implementation unit, and the Unit Director, Assistant Unit Director, and Clinical Nurse Specialist (CNS) for the project unit were engaged in the development and approval of the educational tools and methods for this EBP QI project. Charge nurses (12) and unit practice council (UPC) leaders (10) were educated about the AHA practice standards and possible implications to their practice. The UPC leaders shared the presentation through their standard process, resulting in all staff receiving the same information. The unit leadership identified a unit-based champion to communicate questions and concerns from the staff back to the investigator, and to draft unit-based communications updating staff on project progress. In addition, the Assistant Unit Director, CNS and unit-based champion reminded nursing staff about the practice change during daily huddles.

Engagement of Staff Nurses

In addition to the pre-implementation education, a question-and-answer session was held at the staff meeting one week after the project launch, with an attendance of 20 staff members. During the staff meeting, the investigator presented the project, and staff identified barriers to success. This process resulted in the drafting and dissemination of a Frequently Asked Questions (FAQ) document (See Appendix G). Monthly data updates were provided by email to the provider and nursing teams, and in person at the monthly UPC meetings.

Educational Process

The education of all teams was conducted within a three-week timeframe and was followed by an email to all members of the surgical team from the Chair of the Department of Surgery, describing the EBP QI project and the provider tool. The AHA tools and FAQ documents were printed in poster format and posted in the provider work room and nursing huddle room. Laminated copies were available for reference during interdisciplinary rounds, and badge cards were provided to all team members.

All project documents and presentations were branded with the marketing logo of the "AHA Moment", a concept recommended by experts to distinguish the project from other unit pilots and projects (Heath & Heath, 2007). The branding was also included on the packaging of gourmet cookies that were distributed to all team members at three intervals beginning at the project start date and ending the week before final data collection.

Intervention

The evidence-based intervention following the educational component was three-fold:

1. Charge Nurse assessed telemetry patients between 0400 and 0500 using physiologic criteria, collected the 24-hour alarm profile for each patient, and discussed telemetry requirements with each bedside nurse using the AHA tool (See appendix E).

2. Bedside nurse (LVN or RN) presented the physiologic criteria and alarm profile data to the providers during daily interdisciplinary rounds (IDRs) between 0600 and 0800. After a discussion using the AHA provider tool (See Appendix F), providers (APRNs or physicians) either wrote an order to discontinue telemetry or committed to reassessing the patient the following day.

3. If the patient was still on the monitor after 48 hours, the existing interruptive Best Practice Alert (BPA) was triggered in the EHR, reminding the providers that the best evidence indicated that most patients do not require telemetry after 48 hours (Sandau et al., 2017).

Instruments and Measures

The foundational document for this EBP QI project was the AHA revised practice standard (Sandau et al., 2017). The project utilized physiologic criteria as the basis for the nurse-led intervention. The discontinuation of telemetry criteria, based on physiologic parameters within set boundaries, eliminated any disparities based on gender, age or ethnicity. The revised practice standard was distilled into role-based single page tools and were used to support daily discussions about telemetry utilization. The practice standard was also used to support existing institutional policies in a FAQ document (See Appendix G).

The Healthcare Technology Foundation (HTF) Clinical Alarm Survey was used to quantify the perception of alarm fatigue and current telemetry practices in the pilot unit and allowed for benchmarking nationally. The reliability and validity of the survey has not been formally quantified, but according to DeVon et al. (2007), content validity can be established when a panel of experts agree that the questions listed in the tool correctly obtain the information needed to measure the construct. The HTF Clinical Alarm Survey was developed and evaluated by a 16-member task force composed of experts from the fields of nursing, biomedical engineering, and patient safety to support construct validity (Healthcare Technology Foundation, n.d.). This survey tool has been conducted nationally quinquennially on three separate occasions with more than 5000 respondents, each time yielding similar results (Healthcare Technology Foundation, n.d.), providing a measure of reliability.

The HTF Clinical Alarm Survey, used with the foundation's permission (J. C. Ott, personal communication, August 6, 2019) was distributed via email from the Assistant Unit Director prior to the nursing education sessions using a Qualtrics survey link (See Appendix H and I). The HTF Clinical Alarm survey provided perception of alarm fatigue baseline data as well as measurement of self-reported adoption of industry telemetry standards. Basic demographic data was included in the survey, but did not directly identify participants, protecting anonymity. Participation in the survey was voluntary and the survey was offered by email before the education and again at the end of the 10-week implementation.

Data Collection

The dependent variables, or outcomes, for the project included: (a) proportion of patients on the monitor at midnight daily as a percentage of unit census (b) alarms per day (c) alarms per patient per day. Census and alarm data were collected from EHR reports and reported in aggregate. Alarm frequencies were tabulated using the alarm reports from the physiologic monitor central stations (Philips, 2018), and perception of alarm fatigue responses were captured in the HTF Alarm Survey. Additional balance measures, the number of Code Blue and rapid response calls, were collected from quality dashboards to reflect any adverse impact on patient safety. The independent variable was the implementation of a nurse-led interdisciplinary telemetry utilization discussion during morning rounds.

Timeline of the Project

The project spanned 23 weeks from October 30, 2019 to April 11, 2020. Ten weeks of pre-implementation data, October 30, 2019 to January 7, 2020, were compared with ten weeks of post-implementation data spanning February 1, 2020 to April 11, 2020, allowing for a three-week educational period from January 8, 2020 to January 31, 2020.

Budget

This project was budget neutral as the development of all educational materials were borne by the investigator, and all educational time was included in existing meetings and huddles.

Chapter Five: Results

Evaluation of results is used to determine if the EBP QI project met the intended outcomes (Melnyk & Morrison-Beedy, 2019). The intended outcomes for the project were to reduce number of telemetry monitored patients, to reduce the number of alarms experienced by patients and staff, and to improve the perception of alarm fatigue in the nursing staff while maintaining safe patient care as reflected by Code Blue and rapid response balance metrics. This chapter discusses the participant demographics and project findings

Participant Demographics

The nurse-led intervention was supported by all of the nursing staff members of the pilot unit. Educational demographics of unit nursing staff are presented in Table 1. Apart from the UD and CNS, the nursing staff were not familiar with the AHA revised practice standard as a decision support tool.

Table 1. *Nursing Unit Demographics*

Job Class	Count	Education	Count
Clinical Care Partner	15	Associate Degree	7
Registered Nurse	51	Baccalaureate	43
Licensed Vocational Nurse	6	Diploma	1
Unit Director	1	Masters	1
Assistant Unit Director	1	Other	1
Grand Total	82		61

Patient Demographics

The project unit is a complex adult surgical unit in a large academic medical center. The unit nursing staff provide care for patients from 18 unique service lines, each with its own surgical team.

Table 2. *Patient Population by Service Line*

Service Line	Preintervention Oct. 30, 2019 Jan. 7, 2020 (10 Weeks)	Intervention Jan. 8,2020 Jan. 31, 2020 (3 Weeks)	Postintervention Feb. 1, 2020 Mar. 7, 2020 (5 Weeks)	COVID-19 Mar. 8, 2020 Apr.11,2020 (5 Weeks)	Total
Bariatric	5	3	2	0	10
Emergency Medicine	1	0	0	0	1
Endocrine	1	0	0	0	1
General Surgery	0	0	1	0	1
GI	4	0	2	1	7
Liver	4	2	3	7	16
Medicine-Critical Care	0	2	0	1	3
Medicine-CCU/COU	0	0	0	2	2
Medicine-Internal	0	0	0	30	30
Medicine-Observation	0	0	0	4	4
Nephrology	12	4	2	0	18
OBGYN-Oncology	4	1	2	0	2
OBGYN-Gynecology	0	0	0	2	2
OBGYN-Obstetrics	1	0	1	0	2
Oncology	1	0	4	2	7
Orthopedics	2	0	0	0	2
Peds-Gastroenterology	1	0	0	0	1
Plastics	1	0	0	0	1
Trauma	7	1	1	7	16
Urology	6	0	4	0	10
Urology-Transplant	0	1	1	0	2
Vascular	1	0	0	0	1
GRAND TOTAL	58	18	28	59	163

Table 2 demonstrates a shift in patient population from surgery to medicine during the COVID-19 period. At this time all surgical cases were transferred to the 26-bed sister unit and the pilot unit became a short stay unit to isolate patients awaiting laboratory clearance for the novel corona virus.

Healthcare Technology Foundation Alarm Survey

The HTF survey has been distributed nationally for the past 14 years and allows for measurement of perception of alarm fatigue and benchmarking to process improvement recommendations (Healthcare Technology Foundation Clinical Alarms Survey of Healthcare Personnel, 2016). Three of the HTF questions were utilized in this project to reflect the perception of alarm fatigue in nursing staff. Table 3 displays the Fisher's exact tests with the level of agreement for four nuisance alarm ratings based on time (before versus after). Fisher's exact tests were used instead of the more common chi-square tests because several of the cells in the matrices had less than five respondents.

Inspection of the table found the level of agreement for each of the four ratings to decline from pretest to posttest. However, none of the pretest to posttest declines were significant. Specifically, no significant associations were found between the rating and the time period for: (a) nuisance alarms occur frequently (p = .56); (b) nuisance alarms disrupt patient care (p = .45); (c) nuisance alarms reduce trust in alarms… (p = .29); and (d) total nuisance alarms score (p = .14) (see Table 3).

Table 3. *Fisher's Exact Tests for Agreement with Nuisance Alarm Ratings Based on Time Period*

Statement	Agreement [a]	Time Period: Before *n*	Before %	After *n*	After %	Fisher's Exact Test
6. Nuisance alarms occur frequently:						.56
	Neutral/Disagree	3	20.0	2	40.0	
	Agree	12	80.0	3	60.0	
7. Nuisance alarms disrupt patient care:						.45
	Neutral/Disagree	1	6.7	1	20.0	
	Agree	14	93.3	4	80.0	
8. Nuisance alarms reduce trust in alarms and cause care givers to inappropriately turn alarms off at times other than during setup or procedures:						.29
	Neutral/Disagree	4	26.7	3	60.0	
	Agree	11	73.3	2	40.0	
Total nuisance alarms score [b]						.14
	Neutral/Disagree	1	6.7	2	40.0	
	Agree	14	93.3	3	60.0	

[a] Agreement level categories: "Agree" combined both *strongly agree* and *agree* ratings; "Neutral/Disagree" combined *neutral*, *disagree*, and *strongly disagree.*

[b] Total score was based on aggregating the three ratings together. A higher score reflected more overall agreement with the statements about nuisance alarms.

Impact of Intervention on Monitoring and Alarms

Table 4 displays the one-way ANOVA tests for the five outcome measures based on time period. A marginally significant (p= .05) difference was found for one of the five outcome measures. However, none of the Bonferroni post hoc tests were significant at the $p < .05$ level and all five eta coefficients (η) reflect weak relationships ($\eta < .30$) (see Table 4). Therefore, it cannot be concluded that there are significant and important differences between the three time periods for any of the five outcome measures.

Table 4. *Alarm Census Data Based on Time Period*

Outcome	Time Period	Days	*M*	*SD*	η	*F*	*p*
Count of alarms [a]					.12	1.00	.37
	1. Preintervention	85	1,025.52	382.10			
	2. Intervention	17	1,159.82	502.11			
	3. Postintervention	37	1,010.08	323.76			
Census [a]					.20	2.88	.06
	1. Preintervention	85	24.96	1.15			
	2. Intervention	17	25.29	0.85			
	3. Postintervention	37	25.43	0.80			
Count of patients on monitor [a]					.21	2.99	.05
	1. Preintervention	85	11.92	2.82			
	2. Intervention	17	11.71	2.26			
	3. Postintervention	37	13.08	2.05			
Percentage of patients on monitor [a]					.18	2.17	.12
	1. Preintervention	85	47.78	11.35			
	2. Intervention	17	46.15	8.02			
	3. Postintervention	37	51.38	7.51			
Alarms/patient/day [a]					.20	2.72	.07
	1. Preintervention	85	90.82	40.35			
	2. Intervention	17	108.19	66.22			
	3. Postintervention	37	79.74	30.24			

[a] Bonferroni post hoc tests: $1 \approx 2 \approx 3$; no pair of means were significantly different at the $p < .05$ level.

Note. $N = 139$.

Table 5 displays the one-way ANOVA tests for five outcome variables (count of alarms, census, count of patients on monitor, percentage of patients on monitor, and alarms/patient/day).

The independent variable for this analysis were the four time periods (preintervention, intervention, postintervention, and the Covid-19 period). Bonferroni post hoc tests were also included to further examine the differences between the groups.

Table 5. *Alarm Census Data Based on Time Period Including COVID-19*

Outcome	Time Period	Days	*M*	*SD*	η	*F*	*p*
Count of alarms [a]					.22	2.81	.041
	1. Preintervention	85	1,025.52	382.10			
	2. Intervention	17	1,159.82	502.11			
	3. Postintervention	37	1,010.08	323.76			
	4. Covid-19 period	35	852.40	392.59			
Census [b]					.78	85.84	.001
	1. Preintervention	85	24.96	1.15			
	2. Intervention	17	25.29	0.85			
	3. Postintervention	37	25.43	0.80			
	4. Covid-19 period	35	14.17	7.81			
Count of patients on monitor [c]					.43	12.53	.001
	1. Preintervention	85	11.92	2.82			
	2. Intervention	17	11.71	2.26			
	3. Postintervention	37	13.08	2.05			
	4. Covid-19 period	35	8.94	4.28			
Percentage of patients on monitor [d]					.54	23.37	.001
	1. Preintervention	85	47.78	11.35			
	2. Intervention	17	46.15	8.02			
	3. Postintervention	37	51.38	7.51			
	4. Covid-19 period	35	66.30	15.88			
Alarms/patient/day [e]					.25	3.70	.013
	1. Preintervention	85	90.82	40.35			
	2. Intervention	17	108.19	66.22			
	3. Postintervention	37	79.74	30.24			
	4. Covid-19 period	35	120.45	94.65			

Note: Bonferroni post hoc tests: [a] 4 < 2 ($p = .05$); [b] 4 < 1, 2, 3 ($p = .001$); [c] 4 < 1, 3 ($p = .001$), 4 < 2 ($p = .01$); [d] 4 > 1, 2, 3 ($p = .001$); [e] 4 > 3 ($p = .02$); no other pair of means were significantly different at the $p < .05$ level.

Inspection of the table found all five ANOVA tests to be significantly different between the four time periods. Specifically, count of alarms were significantly different between the four groups (p = .041). Bonferroni post hoc tests found that group four (Covid-19 period) had a significantly lower number of alarms than did group two (intervention) (p = .05). For census, group four (Covid-19 period) had a significantly lower census than any of the other three time periods (p = .001). Regarding the number of patients on the monitor, the Covid-19 group had a lower overall census than did the pre-intervention group and the post-intervention group (p = .001). In addition, the Covid-19 group had fewer monitored patients than did the intervention group (p = .01). For the percentage of patients monitored, the Covid-19 group had a higher percentage of patients monitored than for any of the other three time periods (p = .001). Last, number of alarms per patient per day was higher for the Covid-19 group than for the postintervention group (p = .02). No other pair of means were significantly different from each other at the p <.05 level (see Table 5).

Balance Metrics

Balance metrics to determine possible harm to patients during the project implementation included Code Blue and rapid response rates.

Table 6. *Code Blue Responses Based on Time Period*

Denominator	Period	Code Blue Responses No *n*	No %	Yes *n*	Yes %	Total	Fisher's Exact Test
Patient Days							.12
	Pretest	1,475	100.0	0	0.0	1,475	
	Post	1,423	99.8	3	0.2	1,426	
Unique Patients							.12
	Pretest	305	100.0	0	0.0	305	
	Post	294	99.0	3	1.0	297	

Table 6 displays the Fisher's exact tests comparing the code blue responses based on time period (pretest versus posttest). These tests were done based on two possible denominators: patient days and unique patients. Inspection of the table found neither test to be significant (*p* = .12) (see Table 6).

Table 7. *Rapid Responses Based on Time Period*

Denominator	Period	Rapid Responses No *n*	No %	Yes *n*	Yes %	Total	Fisher's Exact Test
Patient Days							.62
	Pretest	1,468	99.5	7	0.5	1,475	
	Post	1,417	99.4	9	0.6	1,426	
Unique Patients							.62
	Pretest	298	97.7	7	2.3	305	
	Post	288	97.0	9	3.0	297	

Table 7 displays the Fisher's exact tests comparing the rapid responses based on time period (pretest versus posttest). These tests were completed based on two possible denominators: patient days and unique patients. Inspection of the table found neither test to be significant (p = .62) (see Table 7).

Chapter Six: Discussion and Conclusions

This chapter includes a comparison of the results of the scholarly project to the literature, and describes related conclusions, implications, and a series of recommendations. The purpose of this project was to apply the best available evidence to reduce inappropriate telemetry monitoring in a surgical unit. The PICOT question used to frame the literature search was: for surgical patients in an academic medical center (P), does a nurse-led interdisciplinary strategy based upon the revised AHA practice standards (I) compared to a decision support prompt in the electronic health record (EHR) (C) reduce the number of inappropriately monitored patients (O) over a ten week pilot period (T)?

An evidence-based educational intervention was conducted with the project unit nursing staff and surgical teams over a three-week period. Ten weeks of pre-intervention and post-intervention data was compiled from the EHR, alarm reports and existing dashboards. The outcomes of interest included percentage of patients monitored daily, number of alarms per patient per day and perception of alarm fatigue using the HTF Alarm Survey. Balance metrics included number of code blues and number of rapid responses.

There were no statistically significant differences in the overall perception of alarm fatigue responses to the HTF Alarm Survey (p = .14), number of patients receiving telemetry monitoring (p =.05) and alarms per patient per day (p = .07) during the time period including the time period of normal operations. There were statistically significant differences in monitored patients and number of alarms during the period of time identified as the COVID-19 period (p = .001), where the patient population and care delivery shifted dramatically in response to the pandemic. There was no negative impact on patient safety as demonstrated by lack of statistically significant results for the balance metrics of Code Blue (p = .12) and rapid response (p = .62).

Comparison of Results to the Literature

The literature addressing telemetry utilization is primarily authored by two groups, physicians and nurses. The results and implications drawn from the studies vary by primary author's role, metrics trended and methodology.

Agreement with Existing Literature

The AHA practice standards and similar recommendations from the ACC have been available in the literature since 1998, but there has been limited integration into practice.

Similar to the nurse-authored studies of Funk et al., (2018) and Perrin et al., (2016), this project used the patient and staff experience with unintended consequences of monitoring as the underpinning for the educational intervention. Focusing on the role of evidence-based practice allowed the nurses to advocate for their own practice and influence the outcomes of patients (Headley, 2017).

The knowledge deficit regarding the application of AHA revised practice standards (2017) in all members of the care team in the project unit was consistent with the literature (Alsaad et al., 2017; Dressler et al., 2014; Edholm et al., 2018; Funk et al., 2018; Lewis & Oster, 2019; Najafi et al., 2019; Perrin et al., 2016; Rayo et al., 2015; Schachter & Gopalakrishnan, 2019). One possible explanation for this is the length of the practice standard document and the limited use of rigorous studies to support the recommendations. The interdisciplinary educational intervention and one-page tip sheets supported the adoption of AHA revised practice standards, making them more approachable and useful in daily application, as referenced by Patel and Dowling (2016). In contrast to Patel and Dowling (2016), however, the education was provided to all the surgical team members, including bedside nurses and the APRNs, providing an evidence-based common reference. The educational intervention and standardized tools provided speaking points for discussion about necessity of telemetry and the option of discontinuing before the 48-hour discontinuation prompt.

The results of the HTF survey aligned with the results of the 2016 nationwide survey (Clark, 2016), and the results of the study by Allan (2018), with more than 80 percent of the respondents identifying that non-actionable alarms created disruptive and unsafe working environments for nurses. While there was a trend towards a reduction in perception of alarm fatigue, it was not statistically significant.

Many studies used the balance metrics of Code Blue and rapid response rates to identify possible negative impacts of the adoption of the AHA practice standards (Benjamin et al., 2013; Bubb, 2011; Ivanye et al., 2010; Najafi et al., 2019; Perrin et al., 2016). The results of this project align with the literature and determined that there was no statistically significant increase in either Code Blue or rapid response frequencies during the post- implementation phase.

Interdisciplinary collaboration using a common, evidence-based tool successfully supported daily discussions as noted by Bubb (2011), Perrin et al, (2016). This scholarly project found that a nurse-led strategy could be applied successfully to a surgical population in concordance with the quality improvement projects completed by nurses in medical or mixed medical-surgical units (Bubb 2011; Perrin et al., 2016; Zadvinskis et al., 2019). A nurse-led strategy was proposed by Phillips et al., (2019) as a next step in their telemetry stewardship QI work.

Strong executive leadership support is highlighted as an essential element for a successful evidence-based project (Beeber et al., 2019), and this was demonstrated in the support from the chair of the department of surgery, the CNE, CMO and the project unit leadership by creating time on scheduled meetings and sending reminders to the teams about the expectation to use the AHA revised practice standards in daily interdisciplinary rounds. This is consistent with works of Dressler et al. (2014), Funk et al. (2018) and Perrin et al. (2016) who highlighted strong executive leadership support as essential for successful change management.

Deviations from Existing Literature

The project also revealed some findings that disagree with the literature. The deviations were predominantly in methodology, outcome metrics, patient population and the version of the AHA practice standard utilized. Many physician-authored studies determined that 30 to 40 percent of patients on telemetry monitoring did not meet recognized criteria presented in the AHA practice standards (Alsaad et al., 2017; Bulger et al., 2013; Chen et al., 2017; Chong-Yik et al., 2018; Ivanye et al., 2010; Sandau et al., 2017). Of note, physician-authored studies tended to use retrospective reviews and focused on cost reduction, resource utilization, and length of stay as primary metrics (Benjamin et al., 2013; Chong-Yik et al., 2018).

This EBP QI project applied an educational intervention and pre and post intervention design that was most commonly referenced in nursing studies but differed in that a standardized education was provided to the interdisciplinary team of surgical providers and the unit nurses (Funk et al., 2018; Patel et al., 2016). The surgical patient population was unique to this project as all studies in the literature referenced either medical or mixed medical surgical patient populations (Brug et al., 2018; Bubb, 2011; Chen et al., 2017; Patel et al., 2018; Perrin et al., 2016).

The methodology of this project also varied from the nursing studies in the literature. This project measured number of patients on the monitor at the midnight census rather than the length of time patients were monitored as described by Bubb (2011) and Perrin et al. (2018). This project also used an educational intervention based the AHA practice standards reduce inappropriate telemetry monitoring to reduce alarm burden, whereas the studies completed by Allen (2018), Lewis et al. (2019) and Funk et al. (2018), referenced telemetry stewardship but focused primarily on telemetry hygiene standards developed by the American Association of Critical Care Nurses (AACN).

The physician informaticists in the project facility developed and implemented order sets over the previous year with disruptive reminders to consider discontinuing telemetry similar to the works of Alsaad et al., (2017), Dressler et al., (2014), Edholm et al., (2018), Najafi et al., (2019), Rayo et al., (2015), and Schachter and Gopalakrishnan (2019). Najafi et al. (2019) found that EHR prompts alone changed physician practice in an academic medical center, possibly reflecting the impact of institutional culture on practice change. Without the implementation of order sets requiring responses, as described by Dressler et al (2014), the reminders at the project institution were largely disregarded by the ordering teams and had no measurable impact on ordering practices. Finally, all studies available at the time of the literature review were based on the 2004 AHA practice standards (Drew et al., 2004), which did not include suggested monitoring durations and applications for a surgical population.

Alignment with Theoretical Frameworks

Neuman's Systems Theory provided a strong foundation for the analysis of the interactions between monitoring technology, patients and nurses, and the impact of alarms on wellness and safe work environments (Neuman, 2002). The nurse-led interdisciplinary intervention, the wellness bundle (Grimley & Branom, 2019), and the vision of the institution aligned seamlessly in this project to guide choice of outcome metrics. If this had been a physician-led project, Neuman's holistic nursing model may not have been as impactful and the outcomes measures may not have been as patient-centric.

Application of the Stetler Model of Research Utilization led the investigator to assess the successful initiatives adopted by the health system and the collaboration between the nurses and providers on the project unit. The project supported the order set revisions by providing a common point of reference for telemetry monitoring. All team members at the academic medical center had participated in QI projects, although rarely in collaboration. The project planning using the Stetler model promoted interdisciplinary collaboration between the team members.

Understanding the drivers for change for the providers and nurses was essential for the development of meaningful educational presentations that delineated the team members' roles in telemetry stewardship. Knowles' theory of adult learning (1978) provided the underpinning necessary to determine the drivers for change for the care team members. The nursing presentation included unit-based data including alarms per day, frequency of calls from monitor technician, and percentage of patients discharge home from the monitor. The provider presentation included delays in transport to tests for patients on monitors, off-hour calls for rhythm disturbances that did not require intervention, and the potential to reduce the cost of care related to length of stay and unnecessary testing. All presentations included the number of alarms per patient per day and the impact on rest and recovery.

Contribution to Science

This project contributes to nursing science as it is the first known application of the 2017 AHA revised practice standards in a surgical unit. The revisions to the 2004 practice standard (Drew et al., 2004) refined the criteria for telemetry monitoring of surgical patients, and at the time of the literature search there were no studies demonstrating the application of new recommendations to practice in a surgical unit. The project results, while not statistically significant, provide a baseline for ongoing research and QI project work in the surgical population.

Summary of the Literature

Over the past decade, many studies addressing the impact of inappropriate telemetry monitoring in non-ICU settings have been published. Application of the AHA revised practice standards are limited in the literature, but there are many physician and nurse-authored studies that have determined that the 2004 AHA practice standards can be adopted safely in medical surgical units. Careful consideration of the practice setting and the drivers for change, including system goals and established frameworks, guided successful project planning and implementation. And finally, nurse led interdisciplinary EBP QI projects with strong leadership support have proven to be effective in supporting sustainable telemetry stewardship initiatives.

Conclusions and Implications

Future Research Opportunities

The results of the project and the results in existing literature suggest that telemetry stewardship is a complex issue that requires local and systems approaches to ensure the correct patients are monitored for the correct reasons and durations. Despite the availability of the practice standards based on the best available literature, the application of data-based standards at the bedside is lagging. This gap is affecting systems, staff and patients. Retrospective reviews and prospective QI projects across a variety of settings have determined that the AHA practice standards can be applied without causing harm, but as recognized by Sandau et al., (2017), there is a paucity of research in support of appropriate QTc and continuous ST-segment monitoring and parameters for electrolyte monitoring. QTc measurements for anti-nausea and analgesic medications used commonly after surgery were not included in the project but could provide valuable insights for future application. More specific guidance regarding calcium monitoring would also be valuable for the endocrine service.

Once the AHA practice standards are integrated into practice, there are downstream issues that lack academic rigor, including the safest ratio of nurses to monitored patients and ratio of monitor technicians to patients observed that could provide the foundation for policy changes at local and national levels. Application of Post-traumatic stress disorder research and trauma-informed care could also be applied to reduce the stress of sudden alarms and alerts on patients and staff in the workplace. We are lacking the knowledge about the impact of alarms and alerts on an individual level, which could inform workplace concerns including burnout and intent to leave the profession.

Telemetry stewardship is the first step towards reducing the burden of alarm fatigue. Once adopted, addressing the American Association of Critical Care Nurses (2018) telemetry hygiene standards for both ECG and pulse oximetry monitoring will further reduce alarms (Funk et al.,2018; Lewis & Oster, 2019). There is no practice standard available in the literature describing evidence-based indications for pulse oximetry monitoring. Alarms generated by pulse oximetry monitors contributed to approximately 46 percent of the overall monitor alarms in the project unit. A review of the literature could determine a baseline standard to guide pulse oximetry ordering in the inpatient setting. All new monitoring technologies require thoughtful consideration regarding alarms and alerts to avoid compounding known patient safety concerns.

Future Application of Project Implementation and Findings

Telemetry stewardship was the first step in a multilevel approach to address the safety concerns related to alarm fatigue and to improve the patient experience. The project provides the tools to develop a spread strategy in support of the EHR order set revisions to guide practice, and the alarm survey provides the baseline for adoption of telemetry best practices. The project provides the foundation for future QI projects and ongoing research in the impact of technology on staff and patients.

Methodological Enhancements

This project demonstrated the application of the AHA practice standards in one complex surgical unit with multiple surgical specialties but there were limitations to the project.

Project Design

The project was implemented in a single surgical unit, possibly limiting the application of the EBP QI process to other surgical units. The project was conducted in a single surgical unit with eighteen admitting teams. The large number of unique teams may have benefited from data updates and reminders to ensure ongoing attention to telemetry stewardship in the post-intervention phase. A communication with metrics was drafted for the chair of surgery to disseminate in the fifth week of the intervention, but the distribution was withheld as teams shifted their attentions to new workflows and infection prevention strategies. Frequent data updates and reminders from leadership may support the ongoing engagement during the critical practice change adoption periods. Expanding the scope of the project to include other surgical units and assessing the same outcome metrics would further support the project findings and provide future areas for investigation.

The ongoing education of rotating medical and surgical team members in academic medical settings provide an educational challenge. The one-time educational presentation only captured the attention of the existing cohort of residents and interns, limiting possible impacts to the current cohort. Adding telemetry stewardship to the standard education of all services in the health system would provide a foundation for continuous improvement. Including a measure of telemetry stewardship in compensation strategies has been successful in physician studies and could be applied locally with the chief residents. With the frequent rotation of physicians and the large number of service lines, extending the implementation period and adding regular provider education updates may have reduced the burden of explanation of the AHA tools with each new rotation on the nursing team.

Electronic Health Record Constraints

Despite access to many sources of data, the data collection and compilation were cumbersome and not easily applied to a culture of active daily management. Simplifying the data collection methods, encouraging data transparency across units, and providing access in standardized dashboards would support system efforts in support of telemetry stewardship and creating a healing environment. Additionally, the EHR reports reflected telemetry overall monitoring and there was no differentiation between ECG and pulse oximetry monitoring. In daily calls to the unit over a three-week period, before the shift in patient population in response to the pandemic, of the bedded census of 25 patients, the average number of patients with ECG monitoring was eight, a 30 percent reduction. While the staff felt that there were fewer patients on ECG monitoring, it was not reflected in data due to reporting constraints.

The existing EHR order sets bundled the ordering of pulse oximetry and ECG monitoring together with the initial order but require two separate orders to discontinue monitoring of each parameter. The providers assumed that discontinuing ECG monitoring included pulse oximetry, which may have contributed to overuse of pulse oximetry. Order set revisions allowing for a single-click discontinuation of both physiologic parameters could further reduce alarm burden and improve the patient experience.

Pandemic Impact

Most notably, five weeks into the post-implementation phase of the project, the project unit population changed drastically in response to local and international pandemic clinical surge preparation strategies. During this time, the health system reduced elective surgical cases by more than 75 percent, and all surgical patients were cohorted in another surgical unit. The project unit became the dedicated COVID-19 rule-out unit, with a shift in patient population to primarily medicine patients. The patient population that was cohorted in the pilot unit were stable patients awaiting laboratory confirmation of COVID-19. These patients, in times of regular operations, were managed in the 48-hour observation unit, but the observation unit was closed to support surge planning and consolidate limited supplies of personal protective equipment (PPE). If the patient was cleared, negative for the virus, they were discharged home. If the patient returned a laboratory result of positive for COVID-19, they were reassessed and either transferred to the medical unit or remained in the pilot unit until discharge. The average result time for the COVID-19 test changed over time as a result of access and rapid changes to laboratory capability from 24 hours in early March to less than four hours by April, further confounding the census data in the COVID-19 time period. Additionally, the monitoring data was collected with the midnight census, but the alarms data reflected the alarms for all of the short-stay patients in the previous 24 hours, another confounder.

The COVID-19 medical team, composed of Internal Medicine physicians and nurse practitioners, were not included in the AHA education in the project design, and the evolving nature of evidence supporting safe patient care of these patients resulted in wide variation of monitoring practices, most erring on the side of caution, but rarely including ECG monitoring.

The shift in patient population and the dramatic reduction in unit census starting in the sixth week of the ten-week post-intervention data collection phase, are reflected in the outcome metrics. As the teams developed standardized order sets, the COVID-19 patients were primarily monitored using pulse oximetry, a parameter that was included in the data collection due to coding constraints. One half of the pilot unit was closed in anticipation of surge. The patients in the remaining 13 beds had variable lengths of stay from four hours to 48 hours. The care of the COVID-19 patients differed from the regular unit population as a result of strict isolation requirements. The single patient occupancy room doors were required to stay closed at all times, limiting the acoustics of the bedside alarms in the unit. This change placed an additional burden on the monitor technicians to communicate the alarm statuses to the nurses by telephone. Once the call was received, the infection prevention process to enter the room required donning of PPE, further delaying staff response to alarms. The staff concern around rapid desaturation in the COVID-19 patient, resulted in very tight alarm parameters, and, as a result and increase in alarms per patient per day. The AHA practice standards were applied, however, when unit nurses suggested ECG monitoring to measure QT segments of patients receiving hydroxychloroquine rather than exposing ECG technicians unnecessarily by obtaining portable 12 lead ECGs.

The final five weeks of the project implementation were a time of great change and uncertainty, with daily changes to practice guidance for monitoring expectations and management of the COVID-19 population. Future QI projects addressing telemetry monitoring would be strengthened by including the severity of illness scores, a metric not captured in the project data collection, providing a standard measure to address the impact of the project in times of patient population variation.

Local Application

At a local level, five unique opportunities to expand on the project implementation were highlighted.

1. The lack of access to meaningful reports that detail the number of patients on ECG monitoring limit ongoing QI efforts in support of telemetry stewardship. Development of real-time ECG monitoring and alarm frequency dashboards similar to the existing capacity dashboards would support small tests of change and longitudinal data collection.

2. Adoption of the AHA revised practice standards across the health system in adult non-cardiothoracic surgical patients is the vision of the health system leadership. Although the spread strategy was interrupted as the system pivoted to plan for potential surge of COVID-19 patients, two additional surgical units received the AHA education and one had adopted the AHA practice standards into their daily rounds before the surgical slowdown. The providers in the observation unit received the AHA education before it closed temporarily to shift physical and labor resources in the pandemic response. Once the health system resumes normal operations, including the resumption of elective surgical cases, the project will be continued in the units

already educated as well as the remaining surgical units. The Medicine units in the main campus are planned for inclusion in the third phase of implementation before planning implementation at the second campus.

3. The data collected by the project could be used for retrospective reviews of the impact of age, gender and surgical service line on ordering practices to further add to the body of knowledge locally. Retrospective reviews of the data many also support the reporting of outcome metrics identified by physician-authored studies including cost of care and length of stay. The patient experience, as reported by third party discharge surveys, could also be trended for the impact of reduced alarms on the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) standard survey question relating to quietness of the environment at night.

4. Readmissions to the hospital and the related modifiable risk factors are a concern to hospital leadership. Identifying the possible relationship between patients who are discharged home directly from monitored status and readmission rates has been discussed as a possible retrospective research project using the project data.

5. A best practice to address alarm fatigue in health systems includes the development of an interdisciplinary alarm committee (Pelter et al., 2017). The committee was convened in the pre-intervention phase of the project and is using internal resources to standardize physiologic alarm reporting at a unit level as its first initiative. The HTF Survey data and the development of accessible alarm reports will be used to determine the impacts of future educational projects and the possible use of artificial intelligence software and systems engineering to address the burden of alarms in patients and staff (Cvach, 2012). A retrospective review of the alarm data with a focus on the source of the alarms could also inform future discussions about modifying default alarm parameters (Association for the Advancement of Medical Instrumentation [AAMI], 2015).

Introduction of new monitoring parameters necessitate further discussion about the application of additional technology and the resulting alarm burden. The Joint Commission (2014) issued a recommendation of ventilation monitoring for high risk opioid patients which includes continuous respiratory rate, pulse oximetry and capnography monitoring. As the project unit, and the health system, begin to incorporate capnography into the standard of care for high risk opioid patients, it is incumbent on leaders to develop parameters for utilization and work with clinical engineering departments to standardize alarm default parameters to limit the additional burden of alarms in the surgical population.

Systems Application

Telemetry stewardship, or more specifically, overuse of telemetry monitoring, is a common phenomenon in academic medical centers. Incorporation if the AHA practice standards into core curriculum of nurses and providers may facilitate the transition from older practice models, based on past experiences, to an evidence-based approach.

Fiscal responsibility in healthcare has become the focus of payors and health systems, with payor requirements prompting practice change in response to performance metrics. Telemetry stewardship is a practice that could be addressed from payor and systems perspectives similar to the work in progress with antibiotic stewardship and radiologic study utilization (American College of Radiology, n.d.; American Society for Microbiology, 2020).

Role of DNP-Prepared nurse in EBP

The eight essentials for DNP practice provided a framework for this EBP QI project (American Association of Colleges of Nursing, 2006) that addressed quality, safety and the patient and staff experience in the workplace. A DNP-prepared nurse is uniquely positioned to assess telemetry stewardship and to work with teams at a local level to assess the current state, review the literature, and develop implementation strategies (Chism, 2019). Additionally, developing partnerships with PhD-prepared nurses to develop original research studies to further strengthen the work towards safe and healthy working environments will advance nursing science and potentially reduce the time lag between knowledge discovery and clinical application.

Final Summary

Reducing inappropriate telemetry monitoring in a surgical unit in an academic medical center is an achievable goal that has many implications to the institution, nurses, and patients. The utilization of technology in inpatient settings, without guidelines for use, may result in potentially harmful unintended consequences to patients and nursing staff. The application of the best available evidence in support of telemetry utilization in a surgical unit addresses the four elements of the IHI Quadruple Aim (2020) that are recommended for successful quality improvement projects in healthcare. The project's patient-centric goals of reducing the impact of monitors and associated alarms and promoting an environment conducive to rest and recovery support the Department of Nursing's holistic wellness bundle (Grimley & Branom, 2019). The perception of alarm fatigue in staff and the actual number of alarms generated by telemetry can be used to address the national patient safety goal of reducing alarm fatigue (The Joint Commission, 2013). Adopting a nationally accepted practice standard supports a standardized care delivery strategy to a population, and may reduce the cost of care, length of stay and facilitate throughput (Benjamin et al., 2013; Chong-Yik et al.,2018). And finally, providing an environment with fewer disruptions and alarms to create a safe working environment for nurses and a healing environment for patients and families could increase joy in the workplace and reduce burnout in bedside nurses.

This project contributes to nursing science as this is the first known project to apply the AHA practice standards in a surgical unit using a nurse-led interdisciplinary strategy. The results of the project will be used to develop more sensitive reporting tools that will be used to determine the spread of the AHA practice standards to all adult non-ICU units at an academic medical center. Additionally, the results of the HTF Clinical Alarm survey will also be used to support ongoing quality improvement efforts to reduce alarm fatigue across the enterprise. This EBP QI project highlighted the gap between the science and practice and demonstrated that DNP-prepared nurses are uniquely positioned to address complex longstanding healthcare challenges.

Appendix A: Neuman Systems Theory

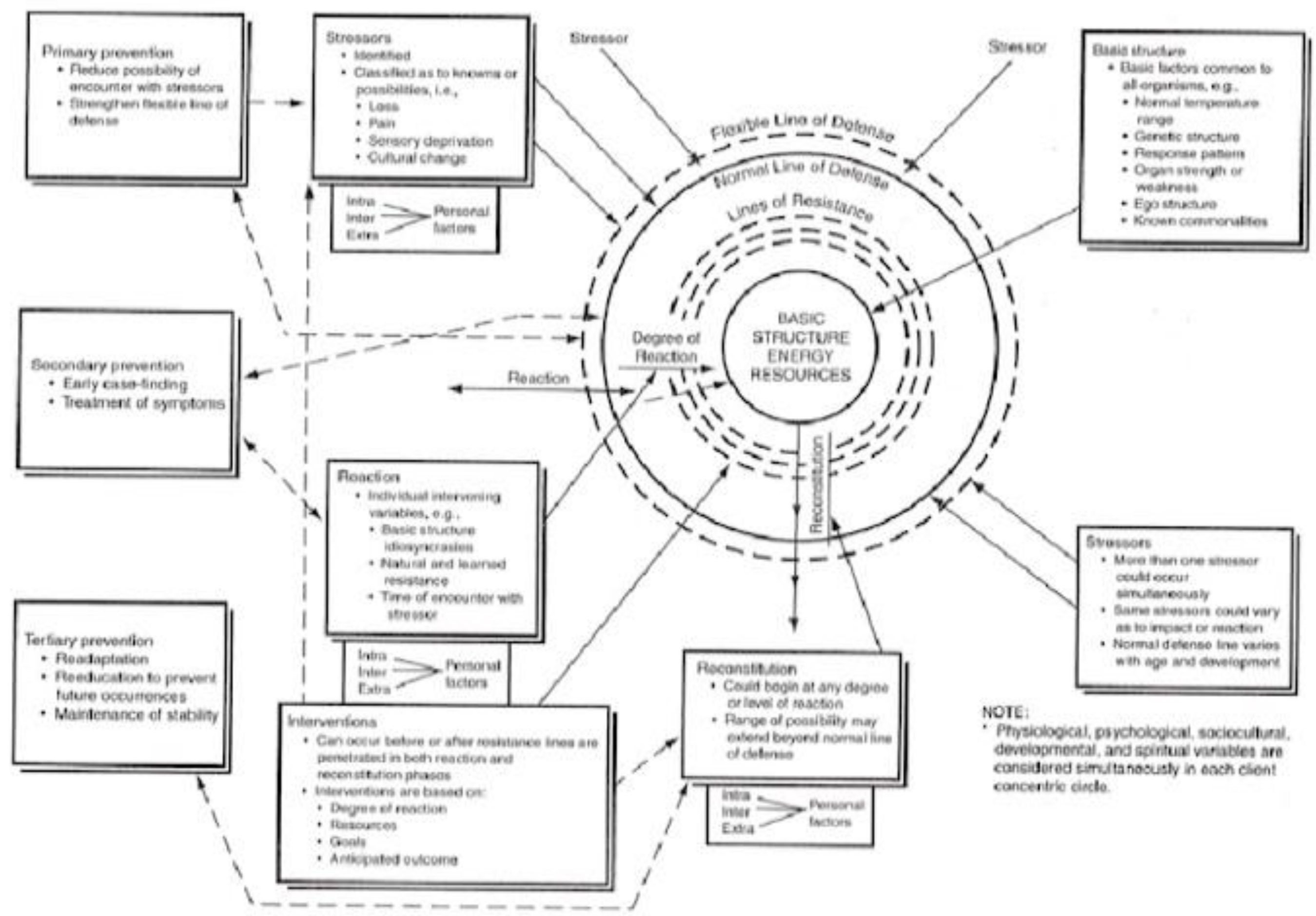
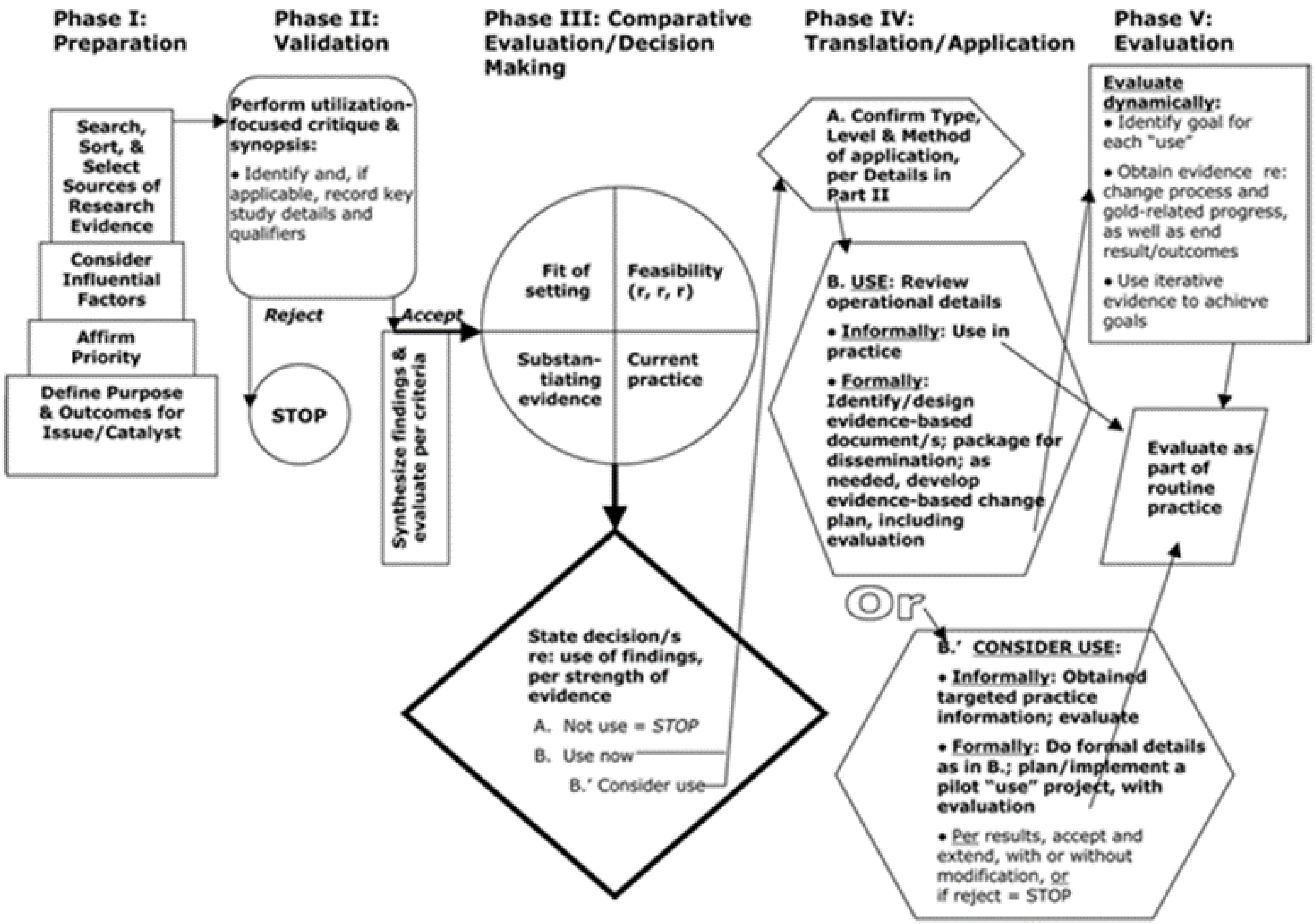


FIGURE 1-3. The Neuman Systems Model. *(Original diagram copyright © 1970 by Betty Neuman.)*

Retrieved from https://sites.google.com/site/bettyneumanssystemmodel/home/essential-concepts

Appendix B: Stetler Model of Research Utilization



Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0029655401478390

Appendix C: Table of Evidence

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
Allan, S. H. (2018). Nurse perception of alarm fatigue impacts compliance with alarm management. *American Nurse Today*, *13*(5), 26–28. https://www.americannursetoday.com	To quantify the impact and root causes of alarm fatigue in an ICU using the National Clinical Alarm Survey (Healthcare Technology Foundation). Tool used to develop a focused educational intervention for nursing staff	• Single Intensive Care Unit in an academic medical center • 23 nursing staff participated in the pre-survey (38% of all staff) and 13 (21% of all staff) competed the post survey Educational intervention provided over 8 weeks- unclear if all staff were included	• Staff surveyed pre and post an 8-week intensive multimodal educational series that included data presentations, review of best practices, 1:1 sessions to demonstrate compliance with alarm customization Survey link emailed to nursing staff and consent was implied by opening the survey link	• Educational event achieved group mean improvement of >20% in knowledge of alarm fatigue, customization of alarms and awareness of nuisance alarms	Strengths • The HTF survey has been used as a repeated measures survey (2008, 2011, and 2016) to clinicians to determine perception of alarm fatigue and trend adoption of industry best practices • Tool utilized over time with healthcare professions- primary respondents were nursing (54%). > 1200 respondents for each survey year. • Tool developed by a multidisciplinary

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
					professional team including human factors engineers, clinical engineers <u>Weaknesses</u> • Single site • Survey responses not robust- possible response bias • Improvement not quantified for statistical significance and methodology not defined • Questionable if ICU interventions transferable to med surg? <u>Application to Scholarly Project</u> • Validated survey for perception of alarm fatigue would be valuable for project and guide future work

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
					• Not enough time for similar rigor of educational activity
Alsaad, A. A., Alman, C. R., Thompson, K. M., Park, S. H., Monteau, R. E., & Maniaci, M. I. (2017). A multidisciplinary approach to reducing alarm fatigue and cost through appropriate use of cardiac telemetry. *Postgraduate Medical Journal*, *93*(1101), 430–435. https://doi.or	Physician-led quality improvement (QI) project to reduce alarm fatigue and cost of care by reducing inappropriate telemetry monitoring	• Progressive care unit at Mayo Clinic campus Jacksonville, Florida-teaching hospital • 27 telemetry capable beds. Primary population step-down patients between ICU and med-surg • Care team included APRN or Resident, and Attending • Most patients were on	• Pre-implementation data collection 13 weeks (January 2015-March 31, 2015) with some additional retrospective data collection • Survey of nurses of perception of alarm fatigue using REDcap and Likert scale questions • Data used to develop education designed by MT and RN manager and nurse educator	• Baseline 77% of patients on telemetry (31% inappropriately monitored) • Post intervention, 67% of patients on telemetry-10% reduction P< .001 • One year follow up 69% on telemetry. Inappropriately	Strengths: • Protocol being expanded beyond PCU • Survey is a validated tool Weaknesses • Singe site, non-randomized • Excluded alarms from Pulse ox, ventilators and BP in alarm counts-incomplete view of problem • Manual processes-did not incorporate EHR Application to Scholarly Project: • Nurse-led strategies have been used successfully at practice site

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
g/10.1136/postgradmedj-2016-13476410.1136/postgradmedj-2016-134764		telemetry with or without an order, Those with an order often did not meet AHA guidelines	as the basis for a protocol which included assessment of AHA guidelines and basics of telemetry • Order checks twice daily • Collected alarm data • Nurses reminded ordering teams of the necessity or not of telemetry using pages or phone calls • Primary outcome measures: percentage of patient on telemetry, percentage of patient with orders that did not meet AHA	monitored 9% • 8336 ECG alarms recorded (4% considered actionable) False positives 86% of alarms • 27% reduction in nurses' perception of alarm fatigue 82%-55% (p=.006) and Perceived reducing ion alarm fatigue interference with patient care by 31% -8%-49% (p= .004)	•

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
			criteria, and Nurse perception of alarm fatigue • Statistical methods used, Paired t-test, X^2, Mann-Wilcoxian equation	• Nurses survey Cronbach alpha 0.81. •	
Brug, A. M., Hudson, K. M., Moore, R., & Chakraborti, C. (2018). Choosing telemetry wisely: A survey of awareness and physician decision-making regarding AHA telemetry practice	To assess the decision-making processes of Hospitalists after 5 years of focus of reducing inappropriate telemetry in the Choosing Wisely Campaign (2013) and AHA Practice Standards (2004)	Residents, interns and faculty at an urban academic medical center	• Web-based survey • Scenario-based (14) • 3 point Likert Scale (Absolutely monitor, consider monitoring, not monitor) based on AHA (2004) • 5 point Likert scale awareness of AHA guidelines, hospital guidelines	• Response rates 55/149 (37%) • 23 interns, 16 residents, 16 faculty • 53% correct answers to scenarios • Inconsistent responses to Class II recommendations (38.2% overuse and 27.6% underuse)	Patterns of behavior in healthcare may not follow the best evidence. Barriers to adoption include complexity of the recommendations, limiting the easy dissemination. Practices of colleagues may influence behaviors. Cultural factors including fear of litigation, cookie cutter medicine, or of missing something could guide choices rather than best practices.

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
standards. *Journal of General Internal Medicine*, *34*(4), 496–497. https://doi.org/10.107/s11606-018-4769-z			reliance of experience • Analysis of variance tests mean correct by level of training (attendings/residents)	• Higher level of training not statistically significant for scenarios • Awareness of AHA guidelines statistically significant based on level of educations (Fisher's exact T p=0.021) • 87.5% of MDs surveys admitted that the relied on past experience over practice standards (no difference for level of education)	Strengths • Data aligns with work in other studies that identified multiple barriers to adoption ○ Guidelines too cumbersome ○ Conflict with experiences • Standardizing EHR to error-proof choices may be option to consider ensuring best practice Weaknesses • Single site • Single team • Small sample (response bias) • Did not use most recent guidelines

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
Bubb, C. (2011). A timely practice; a nurse-driven telemetry dis Bubb, C. (2011). A timely practice: A nurse-driven telemetry discontinuation protocol. *The Pennsylvania Nurse*, *66*(4), 6–10. https://www.ncbi.nlm.nih.gov/pubmed/22359965	To implement a nurse-driven telemetry discontinuation protocol to reduce overall telemetry time, improve throughput, and reduce delays in care.	• 40 bed cardiopulmonary telemetry unit in 517 bed tertiary care hospital • 357 patients included in study • Hospital part of 20 hospital system affiliated with University of Pittsburgh Med Center • All patients admitted with telemetry orders	• Method, Design and • EBP change project • Interdisciplinary team defined the nurse-driven protocol criteria • IRB waiver for informed consent due to minimal risk for subjects • Nurses (35/40) educated over 2-week period on criteria and collaboration strategies • Overview presented to unit councils, executive committees and Medical groups • Marketing with awareness posters	• 21 %Decrease in overall monitor time reducing monitor time by 24 hours P< .006 • Telemetry orders may not always be appropriate • Improved throughput	• How many nurses on the floor? <u>Strengths</u> • Multidisciplinary team including MDs, Nursing directors, educators, risk management, quality director and nursing staff. <u>Weaknesses</u> • Provider pushback to EBP standards • Criteria physician-centric and may be confusing for RNs and limit the effectiveness • Unpredictable fluctuations in patient volumes over time not accounted for <u>Application to practice site</u> • Workflows appear comparable

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
			• 10 week project with 4 weeks blinded data collection preintervention, 2 weeks of education, 4 week post-implementation with daily use of the protocol by bedside nurse • Protocol based on diagnostic criteria from AHA (2004) • Data collected include order time, DC order time. Analysis using t-test for independent samples		
Bulger, J., Nickel, W., Messler, J., Goldstein, J.,	Collaborative project between American Board of	5 recommendations, based on the input of 9	• Surveys of organizational leadership • Surveys of staff	• 150 opportunities identified	• MD misunderstanding that telemetry=closer

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
O'Callaghan, J., Auron, M., & Gulati, M. (2013). Choosing wisely in adult hospital medicine: Five opportunities for improved healthcare value. *Journal of Hospital Medicine*, *9(9)*, 486–492. https://doi.org/10.1002/jhm.2063	Internal Medicine Foundation and Society of Hospitalist Medicine (SHM)to address overuse of medical tests and procedures-the Choosing Wisely Campaign Provide evidence-based recommendations for focused reduction of unnecessary test, procedures and monitoring to decreased cost, improve quality and access to resources	specialty associations and 16 additional groups including SMH subcommittee, submitted to ABIM-F SMH committee members 40 SMH subcommittee of 9 representing geographic, experiential and institutional types.	• Literature review • PubMed, MEDLINE, Cochrane library, Internet • English and other language studies up to 2012 • Delphi panel voting • Core criteria including validity, feasibility, evidence, cost, frequency, harm, impact and potential to improve • Likert scales used in electronic surveys to finalize recommendations	• Five recommendations 1. Urinary catheter management 2. Gut prophylaxis 3. Transfusion guidelines 4. Reduce routine labs 5. Continuous telemetry orders require a continuation/ discontinuation strategy	monitoring verified by process • Referenced AHA guidelines • Recommended an interdisciplinary approach including nurses <u>Strengths:</u> • Geographic and practice site variation increasing scalability <u>Weaknesses:</u> • No surgical input • Single perspective <u>Application to practice site:</u> • Hospitalist buy in • BPAs already in use selectively • St Johns used a BPA for telemetry • Increased role of Hospitalists in inpatient settings • Leadership (Chief of Staff) support

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
Chen, S., Palchaudhuri, S., Johnson, A., Trost, J., Pomor, I., & Zakaria, S. (2017). Does this patient need telemetry? An analysis of telemetry ordering practices at an academic medical center. *Journal of Evaluation in Clinical Practice*, *23*(4), 741–746. https://doi.org/10.1111/jep.12708	Physician-led retrospective review of telemetry ordering practices using AHA guidelines as the foundation to determine appropriateness of telemetry orders in an academic medical center	Johns Hopkins Bayview, 477-bed urban academic medical center in Baltimore, MD. Medicine and Progressive care units included.	Johns Hopkins Bayview, 477-bed urban academic medical center in Baltimore, MD. Medicine and Progressive care units included. Ordering providers included residents, fellows, Advanced Practice Nurses (APRN) and Physician Assistants (PA) No existing telemetry discontinuation protocol but providers must select an indication for telemetry on initial order from dropdown or enter free text "other: option Excluded from analysis were patients with more	• Review of all patients with telemetry orders in non-ICU telemetry units (100) discharged between April 2014 and March 2015 • 4122 admission orders written • Indications categorized and aligned with AHA standard • Duration of telemetry calculated by time difference between orders and	• Part of ongoing work at Johns Hopkins <u>Strengths</u> • Included all ordering providers <u>Weaknesses</u> • Retrospective review • Single site <u>Application to practice site:</u> • Similar issue with patients being DC home from the monitor

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
			than one write-in indication	discontinuation on time stamps • Patients discharged home without a dc telemetry order assumed to be monitored until DC • 2 physician retrospective chart review • Primary end point- appropriateness of telemetry order • Also trended decisions made based on telemetry and Rapid response calls and code blue on	

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
				and off telemetry • Average LOS, average days on telemetry collected along with demographics and presenting diagnosis • Fixed and variable costs of each significant telemetry event included standard linear depreciation model for telemetry equipment • Orders written primarily by medicine	

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
				service (53.5%) • 20.2% of patients were monitored for non-cardiac related reasons • 65% of patients monitored until DC to home • Wide variation in duration of monitoring	
Chong-Yik, R., Bennett, A. L., Milani, R. V., & Morin, D. P. (2018). Cost-saving opportunities with appropriate	To determine the cost savings of appropriate telemetry monitoring based on AHA (2004) practice guidelines using time-driven	Ochsner Clinic Foundation, New Orleans 432-bed tertiary care hospital 250 sequential inpatients with telemetry orders Exclusions: cardiothoracic	• 2 physician retrospective chart review • Primary end point- appropriateness of telemetry order • Also trended decisions made	• Majority of 250 patients did not meet AHA criteria (76% of telemetry days) and of those patients "few if any"	• Provides baseline cost implications for reducing telemetry in resource-constrained environments <u>Strengths</u> • Detailed analysis of cost breakdown

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
utilization of cardiac telemetry. *The American Journal of Cardiology*, *122*(9), 1570–1573. https://doi.org/10.1016/j.amjcard.2018.07.016	activity-based costing model	stepdown unit and cardiac units	based on telemetry and Rapid response calls and code blue on and off telemetry • Average LOS, average days on telemetry collected along with demographics and presenting diagnosis • Fixed and variable costs of each significant telemetry event included standard linear depreciation model for telemetry equipment	decisions were made based on monitoring data (76% innappropriate telemetry days There was no increase in code blue or rapid responses in inappropriately monitored patients • Difference between monitored and non-monitored day, $34.31/day, with an estimate of $36 540 cost savings for the 250 pilot patients not	Weaknesses • Nurse: patient ratios not described • Use of monitor observers not indicated Application to practice site: • Cost savings and LOS reduction are key goals for the health system FY2020

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
				meeting criteria (annualized to $ 528 648)	
Dressler, R., Dryer, M. M., Coletti, C., Mahoney, D., & Doorey, A. J. (2014). Altering overuse of cardiac telemetry in non-intensive care settings by hardwiring the use of American Heart Association guidelines. *Journal of the American Medical Association Internal*	To integrate the AHA guidelines (2004) into EHR to reduce inappropriate telemetry monitoring in the face of multiple unsuccessful initiatives	Christiana Care Health System: private, not for profit 1100 bed tertiary care center Non-ICU patients >18 years of age	• Design and standardization of telemetry orders in EHR, removal of telemetry orders in order sets when indication did not meet guidelines, requirement to indicate indication and expected duration	• Dec 31-2012 to August 12, 2013. Redesigned orders went live March 18, 2013. Pre implementation data collection 11 weeks, Post implementation data collection 22 weeks • Bedside nurse assessment- nurse empowered to contact MD when telemetry should be reordered or	EHR solution may reduce inappropriate telemetry but does not account for clinical judgement. AHA practice guidelines used for the EHR orders, but no reference to educating providers and nurses as to why the changes were made <u>Strengths</u> • Interdisciplinary with a nursing assessment component • Recognized by TJC as a best practice cost savings? <u>Weaknesses</u> • Single site • Not randomized • Top down approach

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
Medicine, *174*(11), 1852–1854. https://doi.org/10.1001/jamainternmed.2014.4491.				discontinuation believed to be unsafe • Calculated direct and indirect costs for telemetry using Time-motion studies completed to quantify nursing time spent addressing non-actionable alarm. Measured census, code blue, mortality and rapid response rates • Significant and sustained reduction in	Application to practice site • Redesigning order sets time prohibitive for pilot but may be valuable for some populations- removing telemetry from admission order sets and DC from ICU order sets

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
				mean weekly number of patients with telemetry orders (SD) • 1032.3 (32.1) to 593.2 (21.3) – 43% reduction P< .001 • Reduction in mean duration of telemetry from 57.8 (2.4) to 30.9 (0.9) hours- 47% reduction P < .001 • 19.7 minutes of nursing time spent in telemetry tasks • Overall mean daily cost	

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
				reduction $13 199	
Edholm, K., Kukhareva, P., Clarkowski, C., Carr, J., Gill, D., Rupp, A., Morshedzadeh, J., Wanner, N., & Kawamoto, K. (2018). Decrease in inpatient telemetry utilization through a system-wide electronic health record change and a multifaceted hospitalist intervention. *Journal of Hospital Medicine*,	Hospitalist approach to reducing waste to meet the Choosing Wisely guidelines. Evaluation of two approaches in one institution: a system-wide EHR change and a multifaceted approach including education	Academic medical center University of Utah Health Non- ICU patients with at least one acute care day on telemetry (inpatient and observation status included) and complete records including CMI info 46 215 visits included • 92 excluded for incomplete records (0.2%) • 10344 excluded during	• 2-group retrospective observational pre-post intervention • Data source Enterprise data warehouse and manual chart reviews by authors • • Data included from January 2014-July 2016 (excluded the implementation education period Jan-June 2015) • July 2015: System-wide change to EHR for all service lines included requirement to	• Hospitalist telemetry utilization reduced by 69% 95% CI, -72% to -64%, *P* < .001. Service lines not included in intervention reduced telemetry utilization by 22% 95% CI, -27% to -16%, *P*< .001 • Concurrent increase in telemetry appropriateness in Hospitalists 46% to 72%, *P* = .025, and no	<u>Strengths</u> • IRB QI designation • Comparison group with EHR-only intervention included Surgical service lines • Hospitalists and Advance practice providers (not identified as NP or PA) • Also reviewed charts for possibility of not ordering telemetry when indicated <u>Weaknesses</u> • Did not use most recent AHA guidelines • Retrospective design

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
13(8), 531–536. https://doi.org/10.12788/jhm.2933		educational period • Hospitalist visits pre: 3 442 and post: 3 700 • Non-hospitalist visits pre: 13 470 and post" 15 259 Non-intervention group included all ordering service lines besides hospitalists	choose clinical indication and duration for telemetry, also required discontinuation or renewal • Hospitalist team only intervention: 1. Educated to AHA and Choosing Wisely criteria, 2. Removed telemetry order from Hospitalist admission order set March 23, 2015, 3. Telemetry discussed in daily rounds, 4. Monthly feedback in group meetings, 5. Financial incentive to	change in non-intervention group • No reduction in LOS	• Incentive not described-unclear of impact as a driver

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
			division if targets met • Code data trended as ration of events: patient days • Completed chart audits to verify AHA guideline applied correctly to patients who were not monitored but met Class I and II criteria (50 pre and post charts of intervention and non-intervention groups and 100 charts from intervention group only • All patients assessed by dedicated		

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
			monitor observers using 64 variables from admission to D/C • Variables and Chart review completed by 2 investigators and investigator • Statistical analysis using SPSS ver. 18		
Falun, N., Nordrehaug, J. E., Hoff, P. I., Langorgen, J., Moons, P., & Norekval, T. M. (2013). Evaluation of the appropriateness and outcome of in-hospital telemetry monitoring.	To validate application of the American Heart Association Guidelines (2004) in a University hospital in Norway by: 1. Examining existing ordering practices	Prospective observational study over 3 months (Nov 2009- Jan 2010) Haukeland University Hospital Bergen Norway (1100 beds, 107000 annual admissions) N=1194 Adults	• All patients assessed by dedicated monitor observers using 64 variables from admission to D/C • Variables and Chart review completed by 2 investigators and investigator • Statistical analysis using SPSS ver. 18	• 18% Class 1 (monitoring indicated in most but not all) • 71 % Class II (monitoring may benefit but not necessary) • 11% Class III (monitoring not indicated for	• System in place for cardiologists to review low risk pts and DC from telemetry Strengths: • Sample size Weaknesses: Observational study Did not include list of the 64 variables in document • Only noted first arrythmia occurrence

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
American Journal of Cardiology, *112*, 1219–1223. https://doi.org/10.1016/j.amjcard.2013.05.069	2. Assessing types and counts of arrythmias 3. Reviewing changes in management of arrythmias First study to apply AHA criteria to 3 points of the pt continuum: admission diagnosis, telemetry indications and discharge diagnosis	Cardiac and non-cardiac Approved by hospital IRB, Norwegian Social Science Data Services and Regional Committee for Medical Research Ethics		therapeutic effect) • Reassignment during admission occurs esp with confirmed diagnosis of acute coronary syndrome • Overall arrythmia rate 33% • 43% of Class I • 28% of Class II • 47% of Class III • 54 % of arrythmias resulted in a change in management -afib, a flutter and	• Single site study • AHA guidelines does not cover all possible diagnoses • No mention of nursing involvement <u>Application to practice site</u> • No defined role to assess low risk patients • Ideally we would apply 2017 guidelines • Our order sets are not standardized to AHA guideline for starting telemetry monitoring- • Unclear if healthcare in Norway and ordering standards are translatable

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
				non-sustained VT • 10% off all had serious arrythmias (complete heart block, sustained VT and asystole) • 2 Class II pts with cardiac arrest and sudden death • Median LOS by Class • Class I 24 hours • Class II 20 hours • Class III 21 • Class III patients at highest risk of arrythmia requiring intervention	
Funk, M., Fennie, K. P., Stephens, K. E., May, J.	Purpose of PULSE Trial was to test the	6-year multisite randomized clinical trial with	• Study lacked power >80% for impact of	• Knowledge levels improved	Strengths • First known nursing study to

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
L., Winkler, C. G., & Drew, B. J. (2018). Association of implementation of practice standards for electrocardiographic monitoring with nurses' knowledge, quality of care, and patient outcomes: Findings from the Practical Use of the Latest Standards of Electrocardiography (PULSE) trial.	effect of implementing AHA (2004) guidelines on: 1. Nurses' knowledge about ECG monitoring 2. Quality of care in monitored patients (lead placement, rhythm interpretation, 3. Patient outcomes (mortality, in-hospital MI, not surviving cardiac event)	a crossover design 65 cardiac units in 17 academic and community hospitals. Included ICU and Med-surg units Units and hospitals randomized into two groups (stratifying for number of beds and nurses), each receiving the same education and clinical support for education and change management techniques 3 013 nurses participated Primarily white (76%) and Baccalaureate	intervention on outcomes • 4 interactive educational modules delivered electronically and a 20 item pre and posttest (test validated using Kuder-Richardson reliability co-efficient • 5-day direct observation periods at each hospital to observe lead placements, indications for monitoring • Maximum incentive for completing pre test, modules and post test- $50 in gift cards	initially but were not sustained • Quality of care improved, and behavior change was sustained over 25 months related to lead placement and • Appropriate telemetry to AHA (2004) guidelines improved but unclear as to rationale aside from awareness if guidelines •	address the intersection of AHA (2004) guidelines and nursing practice. Weaknesses: • Did not address any efforts to reduce telemetry in participating institutions • Unable to maintain intended blinding of Group assignment to hospitals • Did not have full retention across study period. Two hospitals dropped out, two non-compliant with sharing data and not all staff completed all 3 surveys over time • Study period was inordinately long

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
Circulation: Cardiovascular Quality Outcomes, *10*(2), 1–21. https://doi.org/10.1161/CIRCOUTCOMES.116.003132		prepared or above (72%) Non-ICU units 54%	• Utilized site-specific champions who were educated on change and who collaborated with site investigators • Measurement for nursing education- repeated measures for 3 time periods • Measurement for quality of care- multi-level logistical regression including group, time, interaction term, and adjusted for race, primary cardiac diagnosis. Unit in hospital		• Application to your study?

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
			considered a random effect • Measurement for outcomes- multi-level logistical regression including group, time, interaction term in model, and adjusted for age, race, gender and presence of cardiac diagnosis. Unit in hospital not considered a random effect		
Ivanye, C., Ohuabuhwa, C., Henriques-Forsythe, M., Uma, J., Kemilembe Kamigisha, L., Olejeme,	To compare 2004 AHA guidelines to existing internal policy, developed by an interdisciplinary team, to assess appropriateness	953 bed inner city hospital with 35000 admissions annually Site for 2 academic medical schools All telemetry admissions over 2	• Prospective observational design • Resource management project • 2 MD review of electronic and paper charts	• Most common portal of entry- ED (84.1%) • 81.6% of patients meeting AHA criteria	• Telemetry unit medical directors review low risk patients daily and discontinue telemetry but could be more rigorous

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
K., & Onwuanyi, A. (2010). Evaluation of telemetry utilization, policy and outcomes in an inner-city academic medical center. *Journal of the National Medical Association, 102 (7)*, 598–604. https://doi.org/10.1016/S0027-9684(15)30637-4-9684(15)30637-4	of initiating telemetry	months in 41 bed unit (2006) n=120	• Class I and II considered appropriate, Class III inappropriate • Univariate analysis of demographic and clinical data • Bivariate analysis of groups and associations, X^2 • Positive skew of LOS distribution accommodated using Mann-Whitney and Kruskal-Wallis nonparametric tests • 95% CI and $p<$ 0.05 define significant results Analysis using SPSS version 15	• 83% of patients meeting internal policy CI 95%, 75.4%-89.5% • Degree of agreement between AHA and internal 0.89 (K) • Distribution of patients in 3 AHA categories. Class I 58.3%, Class II 23.3%, Class II 18.3% • Low rate of telemetry events in all AHA groups- 5.8% had an event	• Ongoing education recommended • 18% inappropriately monitored patients provide opportunity to consider further intervention Strengths: • Strong data analytics Weaknesses: • Possible interrater bias • Single center • Individual MD practice decisions not considered in analysis • No mention of nursing involvement Application to practice site • No standardized order set using AHA guidelines-application of

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
				•	2017 AHA guidelines not reasonable per physician informaticists
Lewis, C. L., & Oster, C. A. (2019). Research outcomes of implementing CEASE. *Dimensions of Critical Care Nursing*, *38*(3), 160–173. https://doi.org/10.1097/DCC.0000000000000357	First published study demonstrating the value of the complete adoption of the AACN alarm management recommendations as a bundle to reduce alarm fatigue.	36-bed ICU/Stepdown unit I 368 bed Magnet not for profit hospital 83 RNs	• IRB approval • Exploratory Pretest/posttest design • 6 month project (1 month baseline data, pre- survey, champion education followed by staff education and competency review (2 months), 3 month implementation period, followed by one more post survey and data collection	• 89% of RNs attended training • Perception of alarm fatigue: Nuisance alarms occur frequently strongly agree response (68%to 44 % χ^2 = 8,922 P < .0028) Agree response unchanged Neutral response increased 5%-27% χ^2	Significant reduction in alarm counts and perception of alarm fatigue despite 22% compliance with complete bundle Unclear if the bundle, individual elements or education played the lead role in the outcomes. Strengths • Evidence based intervention based on three foundational publications (2004 AHA practice standards, PULSE Study and AACN practice alert) • Single educator and majority

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
			• Education utilized train the trainer model- single educator • Bundle implementation • Based on AACN recommendations • HTR Alarm Survey 2016 used pre and post (36 questions) • χ^2 and T test analysis • Significance identified as $P < 0.05$ • Educational intervention to CEASE: C: Communicate care procedures that could trigger nonactionable	8.922 Pchi <.0028 • Counts of alarms: 30.45% (52 880 to 36 780) Level 1 (low)decreases 7.7% Level 2 (mod) decreased 39.35% Level 3 (high) decreased 36.18% • Duration of alarms: Level 1 -23 seconds p.045 Level 2 +3 seconds p .9135	attendance to sessions • Competency confirmed • Study design and data collection tools well-defined <u>Weaknesses</u> • Single site/ single unit • Not randomized, no comparators • No discussion about the process to reduce inappropriate telemetry monitoring. 2004 AHA practice standards referenced. • No reference to number of patients monitored or percent reduction related to appropriateness discussions • No power analysis

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
			alarms with MT. Suspending alarms during procedures expected E: Change ECG electrodes daily. Focus on correct lead placement and skin preparation A: Appropriate indication for telemetry (AHA Practice Standards) S: Setup alarm parameters to customize to patient condition E: Ongoing education • Outcome measures: number of ECG and respiratory alarms,	Level 3 +246 seconds P< .001 • Bundle compliance 9%-24% χ^2 5.068 P= .0244 • No adverse events	• Statistical significance of alarm count reduction not indicated • Alarm fatigue survey response rates varied and no way of identifying if same people participated in both • Only 2 questions from Alarm survey reported

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
			perception of alarm fatigue, duration of alarms and bundle compliance		
Najafi, N., Cucina, R., Pierre, B., & Khanna, R. (2019). Assessment of a targeted electronic health record intervention to reduce telemetry duration: A cluster-randomized clinical trial. *Journal of the American Medical Association Internal Medicine*, *179*(1), 11–15.			•	•	

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
https://doi.org/10.1001/jamainternmed.2018.5859					
Perrin, K., Ernst, N., Nelson, T., Sawyer, M., Pfoh, E., & Cvach, M. (2016). Effect of a nurse-managed telemetry discontinuation protocol on monitoring duration, alarm frequency and adverse patient events. *Journal of Nursing Care Quality,*	To develop and implement a nurse- driven protocol AHA (2004 and 2017) developed practice guidelines for appropriate telemetry monitoring in the hospital Many studies have demonstrated the effects of alarm fatigue on staff, the effects	15 bed adult medical acute care unit Capacity 8 monitors John's Hopkins-academic medical center Patient-days: Preintervention 2168 Intervention 2244 Monitor Encounters defined as any stay (transfer or admission) with a telemetry order Preintervention 186 Intervention 221	• Quality improvement project • Pre/post study • 6 months pre-intervention data • 6- month intervention • Workflow survey 7 questions- voluntary and anonymous for RN • Workflow survey to MDs electronically 2 mo. Post- • Protocol developed with interdisciplinary team	• Average Hours/encounter monitored pre 107/ post 74 (P< .01) • 75% decrease likelihood of remaining on monitor until DC in intervention group Odds ratio=0.25; P<0.001: 95% CI, 0.13-0.48 • Mean decrease of 25 hours of telemetry in intervention group (P<	Strong EBP QI project design demonstrating an interdisciplinary approach Strengths: • Nurse driven • Data analysis • Personal conversation Maria Cvach (March 2019) protocol has been spread at JHU and is now incorporated into the EHR at one campus Weaknesses: • Paper process • Single unit Application to practice site

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
32(2), 126–133. https://doi.org/10.1097/NCQ.0000000000000230	of alarms on patient rest, as well the MD misconception that a monitored patient is more closely monitored.		• Base on AHA guidelines (2004) • RN/MD discussion IDRs • Data collected: age, sex, race and number of encounters • *t* test used for continuous variables X^2 analysis for categorical variables • multilevel regression for impact on outcomes • logistic model for impact of monitoring until DC • linear model impact of intervention on total hours monitored	.005; 95% CI, 8.1-41.5) • Average number of patients monitored/day remained at 6 • Staff survey results (n=14) 86% strongly agreed that they would support using the protocol. 71% felt that the protocol improved patient • MD survey (n=39) 83% would support RN-managed protocol • No significant	• Existing nurse driven protocols using EHR Daily interdisciplinary rounds with RNs and MDs already present

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
			• Pre-intervention data 6 months n= 14 192 • Post-intervention data 7 months n= 20 380	increase in code blues or rapid responses during intervention	

Phillips, J., Polomano, R. C., Lerning-Lee, T., & Davis Crutcher, T. (2019). Evaluation of telemetry utilization on Medical-Surgical Units. *Nursing Clinics of North America*, *54*(1), 97–114. https://doi.org/10.1016/j.c	Nurse-led quality improvement project used a timely retrospective review to assess appropriateness of telemetry orders and perception of related alarms.	40-bed medical unit and 32-bed surgical unit at The Hospital of the University of Pennsylvania, an academic medical center with 776 beds
		
		94 unique patients included in retrospective review
			• DMAIC framework
			• 4 week study
			• Order report printed each day in the evening (1900) to guide manual chart review for diagnosis, indication from existing order set, role of provider placing the order, and 2004 AHA class.
			• Time between initial order and DC order calculated
				• 68% of 94 patients did not meet AHA criteria (64)
				• Of cases not meeting criteria the indications included:
				  ○ Electrolytes (21%)
				  ○ Post-Op care (17%)
					Strengths
					• Medical and Surgical units
					
					Weaknesses
					• Single site
					• Nurses solely responsible for data collection and responses
					• 28 days of data collection may have yielded a smaller than required sample size
					• Did not include MD or APRN input or perceptions

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
nur.2018.10.001			• HTF survey to staff "Perceptions, Issues, Improvements and Priorities of Healthcare Professionals to gauge perception of alarm safety • Existing order sets include two time frames: 24 or 48 hours	○ Palpitations (17%) • 78 patients were monitored longer that ordered • Nursing survey results completed by 64 (60%) or eligible nurses. No statistically significant differences between pre and post surveys	Application to practice site Site also has lags between telemetry DC order and removing patients from monitor Possible opportunity for a nursing trigger to remind staff about the DC order
Potluri, A., Kudaravalli, M., Defail, A., Prabhakaran,	To design and implement a telemetry guideline based on AHA 2004	Allegheny Health Network, nonprofit	• Pre post study design Pre data collected November	• Reduction in inappropriate monitoring (9.1%) but not	Described value of an educational intervention Strengths

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
D., Reilly, J. B., & Kapetanos, A. (2017, March 31). Abstract 173: Simple guidance improves appropriate telemetry utilization. *Circulation: Cardiovascular Quality and Outcomes*. https://doi.org/doi/10.1161/circoutcomes.10.suppl_3.173017). Abstract 173: Simple guidance improves appropriate	recommendations and relevant literature search	academic 8 hospital system All medicine teaching team admissions Exclusions: ICU transfers, stepdown units and direct admissions	n=180/ Post collected February/ March n=225 • Education provided in conference and supported by pocket guides	statistically significant ○ Sample size issue? • No change in incidence of codes during post intervention • Estimated savings > $100 000 • Cost analysis calculated using telemetry-bed- days saved/ month	• Sustained behavior change for 2 months • Cost effective intervention • Validates the barriers to adopting practice guidelines in that education is important Weaknesses: • Sustainability with rotating providers in an academic center not discussed Application to practice site • Similar results at single site at practice location (Patel)

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
telemetry utilization. *Circulation: Cardiovascular Quality and Outcomes, 10*(suppl_3), A173-A173. Retrieved from https://doi.org/10.1161/circoutcomes.10.suppl_3.173. doi:10.1161/circoutcomes.10.suppl_3.173					
Rayo, M. F., Mansfield, J., Eiferman, D., Mignery, T., White, S., & Moffatt-Bruce, S. D.	To assess the impact of a system-wide policy to reduce telemetry utilizing standardized	Tertiary care health system with five hospitals and 37 units (total of 1000 beds)	• Cross functional alarm taskforce approach to non-actionable alarms • Mixed methods design:	• Cardiac monitoring decreased by 53.2% (p< .001)	Strengths • Well described interventions • Strong leadership buy-in and support

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
(2015). Implementing an institution-wide quality improvement policy to ensure appropriate use of continuous cardiac monitoring: a mixed-methods retrospective data analysis and direct observation study. *BMJ Quality and Safety*, *10*, 796–802. https://doi.org/10.1136/bmjqs-2015-004137	order sets and multidisciplinary education to AHA 2004 Practice Standards Report commissioned by Chief Quality and Safety Officer and Chief Nursing Officer	3 inpatient units included in data collection	Retrospective review and direct observations • Process measures: cardiac monitoring rate, transport rate and ED boarding rate • Outcome measures: LOS and mortality • Observation used to calculate percentage of true, false and unnecessary alarms • 2004 AHA practice standards tailored to population	• Monitored transport rate decreased by 15.5% (p<.001) • Percentage of false alarms reduced by 50% (p<.001)	• Randomization of observation locations and times • Interdisciplinary alarm taskforce= MDs, nurses, IT, human factors engineers, informatics SMEs and data analytics Weaknesses • Unclear if orders could be extended beyond set timelines (hard stops) Sustainability? Application to Practice Site Revising all order sets not feasible at this time- version upgrade has halted and new work and resistance to changing department-specific order sets

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
			• 12 week data collection pre and post		
Sandau, K. E., Funk, M., Auerbach, A., Barsness, G. W., Blum, K., Cvach, M., Lampert, R., May, J. L., McDaniel, G. M., Perez, M. V., Sendelbach, S., Sommargren, C. E., & Wang, P. J. (2017). Update to practice standards for electrocardio graphic monitoring in hospital	Update to the AHA 2004 guidelines including recommendatio ns for indication and duration of ECG monitoring by patient population Foundational work by the American College of Cardiology Addresses over-use of arrythmia monitoring, alarm fatigue Provide a scientific statement	Subject matter experts commissioned by the AHA to complete a literature review of publications after 2004: studies published in English and available through PubMed, CINAHL, Cochrane and other databases Data compiled into Class of Recommendation s (COR) and Level of Evidence in place from 2004 guideline	• Classification of Recommendatio ns for monitoring (COR) and levels of evidence (LOE) defined • COR 1 Should be performed • COR IIa Is reasonable to perform • COR IIb May be considered • COR III (benefit)No benefit, is not recommended OR COR III (harm) is potentially harmful and should not be performed	• Defined classification s for monitoring • Defined durations of monitoring by condition • List of medications with arrythmia side effects requiring monitors • Recommend ations to optimize QT monitoring	• Standards of practice may not be based in science and not amenable to RCT due to ethical considerations • Gaps identified and presented as opportunity for research • Many patient groups are recommended for reassessment of need for monitoring between 12 and 48 hours Strengths: • Interdisciplinary team • Levels of evidence described Weaknesses:

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
settings: A scientific statement from the American Heart Association. *Circulation*, *136*, e273–e344. https://doi.org/10.1161/CIR.0000000000000527	including review of the most recent evidence Goal was to provide a user-friendly guide for including of best evidence into EHR order sets External peer review by AHA and ACC	Strict adherence to AHA conflict of interest policy	• LOE A,B and C • LOE A-multiple populations evaluated. Multiple RCT or meta-analyses • LOE B-limited populations evaluated. Single randomized trial or non-randomized studies • LOE C- Very limited populations evaluated. Consensus opinions of experts, case studies or standard of care • Section 2: Recommendations for Indication and Duration of		• Levels of evidence rely heavily on expert opinion <u>Application at practice site:</u> • Hospitalists have agreed to adopt where applicable • CMO and CNE requirement to base project on best evidence

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
			Electrocardiographic monitoring of the most interest		
Schachter, J. L., & Gopalakrishnan, P. (2019). Telemetry: Do you have the heart not to order it. *Journal of the American College of Cardiology*, *73*(Supplement 1). https://doi.org/10.1016/S0735-1097(19)33642-3	To improve the application of the AHA (2004) practice guidelines	Greenville Memorial Hospital, SC Telemetry beds only	• 15-month phased introduction of EHR interventions to reduce inappropriate telemetry • Phase 1 all telemetry orders in EHR either 24 hour or continuous • Phase 2 Option for 48 hours added • Phase 3 Nursing education to prompt DC of telemetry per protocolized order sets	• Phase 1 ordering of continuous telemetry dropped from 100% to 61.54% • Phase 2 ordering of continuous telemetry monitoring dropped to 17.7% • Phase 3 Further reduction to 10.4% and a 26% reduction in hours on telemetry	<u>Strengths</u> • Multidisciplinary approach including nursing and EHR • Improvements in duration of telemetry with inclusion of nursing <u>Weaknesses</u> • No statistical analysis <u>Application to practice site</u> • Standardized order sets with embedded AHA guidelines not applied to date • Telemetry beds are a designation often between ICU and

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
			• Statistical analysis ANOVA to test equality of total telemetry utilization in hours per day across 3 phases • Pairwise test with Bonferroni-corrected p-values	• Average duration of telemetry monitoring unchanged until nursing was included	med surg. Practice site has only ICU and med surg, limiting generalizability of study
Sendelbach, S., Sandau, K. E., Smith, L., Krieger, R., Hanovich, S., & Funk, M. (2019). Implementing practice standards for inpatient electrocardiographic monitoring.	To evaluate the impact of an electronic order set based on 2004 AHA Practice Standards for ECG monitoring on occurrence of appropriate monitoring	627 bed hospital in Minneapolis, Min 300 adult patients (>18 years) Medical, surgical, neurological onc and ortho units 30 Residents 64 Hospitalists Telemetry remotely monitored	• Implemented EHR order set in a pre and post quasiexperimental design • Education in person, supported by pocket cards • Balance metrics for adverse outcomes included Code	• Increase in appropriate telemetry monitoring from 48%-61.2% P= 0.03 • Proportion of unexpected adverse patient events	• First nurse-authored paper describing the impact of an AHA-based order set • Study conducted before 2017 Revised practice standards published • Single general admission order set

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
American Journal of Critical Care, *28*(2), 109–116. https://doi.org/10.4037/ajcc2019699			Blue, ICU transfer, death, and Rapid Response calls	• Days or monitoring when not indicated • Determine ordering patterns of hospitalists and residents- Residents more accurate in their ordering patterns after education and implementation	• Difference in results between Hospitalists and Residents may lie in educational method esp describing the new order set Strengths • Interdisciplinary team led by industry experts developed order set • SOI scores used • Inter-rater reliability process determined as part of design • Six days of observation per patient Weaknesses

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
					• Comparison groups did not receive the same education • Nursing not included in the education • Unclear what the workaround was for hospitalists to continue ordering practices as usual- not a hard stop or sunsetting of older ordersets?
Stolzfus, K. B., Bhakta, M., Shankweiler, C., Mount, R. R., & Gibson, C. (2019). Appropriate ultilisation of cardiac telemetry	Quality improvement project using AHA Guidelines (2004) to reduce inappropriate telemetry monitoring on intermediate	University of Kansas Health System, Kansas Eight hospital inpatient progressive care units including cardiothoracic, cardiovascular, medical telemetry/	• PDSA approach with two cycles over two years • 30 day pilot on single unit to determine feasibility (Q1 2015). Huddle intervention with scripted questions about	• Single unit pilot results slight reduction in telemetry utilization 43.3% to 39.3% from Q2-3 but broad	<u>Strengths</u> • Multidisciplinary approach with nurse participation • Pre and post data collection demonstrating change using statistical control <u>Weaknesses</u>

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
monitoring: A quality inprovement project. *BMJ Open Quality*, *8*(2). https://doi.org/10.1136/bmjoq-2018-000560	care units as part of a resource utilization and cost saving initiative. Also addressed were alarm fatigue, and disruptions to patient care	pulmonary hypertension, inpatient solid organ transplant/renal care, and cardiac and family medicine, neuroscience and two medical telemetry Excluded were intensive care units (ICU) Labor and Delivery, and Pediatric units Total number of patients, nurses and providers involved in PDSA cycles not listed Number of cardiac monitors	need for telemetry • PDSA Cycle 1 Q2 to end of Q3 Intervention scripted huddle questions to all 8 units • Pre and post data collected with each cycle and trended on run charts. Data reported out to Acute Care Committee quarterly • PDSA Cycle 2 Intervention Hard-stop on admission orders requiring a rationale for monitoring based on AHA criteria and a	variation across units • PDSA Cycle 1 did not achieve expected goal of a reduction of 20% • Cycle 2 Reduction from Q2 2016-62.4% to 51.3 % a 17.8% relative reduction • Other category utilized 33.5% of the time • Suggest next steps to include a nurse-driven telemetry	• Did not include balancing measures • No statistical analysis • EHR intervention did not include orders written after admission • Possible incomplete intervention in Cycle 1 related to personnel limitations • Utilization based on billing data at midnight and not all communications between MDs and RNs are linked to billing codes • Data skewed by units who require cardiac telemetry until DC (CT surgery, advanced cardiac decline)

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
		available not identified	selection option for “other” with free text space	discontinuation protocol based on defined algorithm	Application to practice site • Capitalizes on existing RN-MD rounds • Hard-stops in EHR not a practice and unlikely to be adopted
Svec, D., Ahuja, N., Evans, K. H., Horn, J., Garg, T., Loftus, P., & Shieh, L. (2015). Hospitalist intervention for appropriate use of telemetry reduces length of stay and cost. *Journal of Hospital Medicine*,	Quality improvement project to determine the impact of the Choose Wisely guideline to reduce inappropriate telemetry monitoring on LOS	Stanford Hospital 444-bed academic medical center: 66 ICU beds, 114 telemetry intermediate ICU beds and 264 beds without telemetry All 5 House staff inpatient internal medicine teams were included (excludes cardiology, pulmonary	• Pre-intervention data collection January 2012-December 2012 • Intervention January 2013-August 2013 • Post intervention extension Sept 2014-March 2015 • Intervention included: daily review of bed utilization identifying telemetry as a possible barrier to DC,	• Nearly half of participants were not familiar with AHA Guidelines (2004) • Reduction in LOS from 2.75 days to 2.13 days (P= .005) in pre and post phase, and sustained improvement through the extension	Strengths • Strong system-wide buy-in to the chose Wisely guidelines and selection of reducing telemetry • Hospitalists received detailed education before study and ongoing email reminders when attending • 8 month timeframe • Cost saving from reduction in telemetry and LOS Weaknesses

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
10(9), 627-632. https://doi.org/https://doi.org/10.1002/jhm.2411		hypertension, hematology, oncology and post-transplant patients). Teaching teams include 1-2 medical students, 2 interns, 1 resident and 1 attending. Total participants: 10 Hospitalists, 56 medical students, and housestaff. 12 Non-Hospitalists served on the wards during intervention, while Hospitalists covered 72% of IM wards.	educational component for trainees led by attending MDs that included pre and post eval, quarterly feedback and financial incentives • Variables include Case Mix Index, and bed use data • Cost savings calculated internally using internal accounting data • UHS Mortality data as a comparator during the project	period to LOS 1.93 days	• Relatively small sample size (not listed numerically) odd? • No randomization • Rotation schedule • CMI as a proxy from patient complexity • No mention of nursing ugh • Surgical service lines not included <u>Application to practice site</u> Similar education proved in a pilot at SMH UCLA with reduction in inappropriate telemetry

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
Zadvinskis, I. M., Schweitzer, K., Murry, T., & Wood, T. (2018). Tele talks: Nurse-led discussions regarding need and duration of cardiac telemetry may impact alarm fatigue, empower nurses, and reduce cost. *Worldviews on Evidence-Based Nursing*, *15*(4), 323–325. https://doi.org/10.1111/wvn.12294	Nursing team reviewed the literature to answer the question if time-sensitive telemetry monitoring compared to continuous monitoring	Large Magnet-designated Midwestern hospital with >1000 nurses Two cardiology inpatient medical units 30 day pilot	• PICOT question (s) drove literature search • Facility SWOT analysis • Review of internal best practices: rounding format • Intervention: interdisciplinary discussion about duration and need for telemetry during daily rounds	• Cost savings quantified • 250 “Tele-talks”. • 77 monitors discontinued • 74 time-sensitive orders written	• Time-sensitive telemetry monitoring is the best practice for med-surg units • Barriers to applying AHA Practice Standards ○ MDs misunderstand-ing nursing ratios Strengths • SBAR communication • QI EBP structure Weaknesses • Basis for IDR communication not described with framework or evidence • Intervention not well developed and multiple outcome measures • Slow spread across other units

CITATION	PURPOSE	SAMPLE/ SETTING	METHODS (Design, Interventions, Measures)	RESULTS	DISCUSSION, INTERPRETATION LIMITATIONS OF FINDINGS
					• Impact of standardized order sets not addressed • Application to practice site: • IDRs in place with most service lines • Unit practice councils in place • Charge nurse-led efforts common

Appendix D: Institutional Review Board Approval

From: Lillig, Paul <PLillig@research.ucla.edu>
Sent: Thursday, November 14, 2019 6:55 AM
To: Lehuquet, Cheryl Diane <CLehuquet@mednet.ucla.edu>
Cc: Miller, Pamela S. <PSMiller@mednet.ucla.edu>
Subject: UCLA IRB Review Not Required

Dear Cheryl Lehuquet,

Based on the information provided in the email below, the quality improvement activities associated with reducing inappropriate telemetry monitoring in the UCLA Healthcare system do not meet the definition of human subjects research as defined by federal regulations for human subject protections (45 CFR 46.102(d) -http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.html#46.102).

Therefore, neither certification of exemption from UCLA IRB review nor UCLA IRB approval of the proposed activities is required.

Please retain this email as formal documentation of this determination.

***Please note: This may not be the only review or approval necessary to conduct this project.**

Please contact our office for an update to this determination if the scope or aims of the activities are revised.

Reference: OHRPP guidance document "Determining Which Activities Require UCLA OHRPP/IRB Review": http://ora.research.ucla.edu/OHRPP/Documents/Policy/3/Activities_Requiring_Review.pdf

Sincerely,

Paul Lillig
GIRB Administrator
310.206.2091
plillig@research.ucla.edu
UCLA OHRPP
Office of the Human Research Protection Program

Appendix E: Nursing AHA Telemetry Assessment Tool

AHA Nursing ECG (telemetry) Assessment Tool

Diagnosis	Assessment	Decision
Cardiac arrhythmia	If the arrhythmia is not being actively managed with medication	Consider removal of telemetry
DNR	Results are not actionable and/or comfort care only	Remove telemetry
Non-cardiac surgery	Hemodynamically stable, no chest pain	Recommend removal of cardiac telemetry
Chest pain	Low risk and troponin negative	Recommend removal of cardiac telemetry
Hypertension Urgency	Systolic BP > 220 mm Hg or Diastolic BP > 120 mm Hg)	Continue cardiac monitoring
Unstable VS	SBP< 95mm Hg, HR > 120 and RR > 20	Continue cardiac monitoring
Potassium imbalance (low)	K+ < 2.9	Continue cardiac monitoring
Potassium imbalance (high)	K+ > 5.2	Continue cardiac monitoring
Magnesium imbalance (low)	Mag < 1.3	Continue cardiac monitoring
Drug overdose	Monitor until free of influence of drug	Consider removal of telemetry monitoring
Telemetry NOT Supported		
Non- cardiac surgery who are low risk, asymptomatic and hemodynamically stable	Stable Pulmonary Embolus without hemodynamic instability	Febrile without shock
Chronic stable atrial fibrillation	Chronic PACs /PVCs	Chronic Hemodialysis
Respiratory Illness: pneumonia, asthma or COPD without underlying cardiac disease	History of implanted pacemaker or AICD without evidence of malfunction or misfiring	Anemia not requiring a transfusion

Adapted from Patel & Dowling, 2016 and Sandau et al., 2017. Reviewed by Dr. Gregg Fonarow, University of California Los Angeles, Cardiology, 2019

Appendix F: Provider AHA Telemetry Assessment Tool

Provider AHA Guidelines for ECG (Telemetry) Monitoring

Class 1 Indications (review in 24 hours)	Class 2 Indicators (review in 48 hours)
Chest pain, low risk, unchanged ECG, negative cardiac enzymes	Chest pain, intermediate or high risk
Unstable VS-SBP < 95m HR > 120 and RR > 20	AV block 2nd or 3rd degree
	New onset or uncontrolled atrial tachyarrhythmia
K+ < 2.9 or > 5.2	Infective endocarditis
Magnesium < 1.3	Acute decompensated CHF
Calcium	Pericarditis
Non- Cardiac major thoracic surgery	CVA, acute
Syncope of unknown origin	Syncope, suspected to be of cardiac origin
Hypertension urgency (Systolic BP > 220 mm Hg or diastolic BP > 120 mm Hg)	Use of QT prolonging medications
Drug overdose or toxic ingestion of arrhythmogenic substances	
New use of beta blockers, calcium channel blockers or amiodarone	

Telemetry NOT Supported		
Non- cardiac surgery who are low risk, asymptomatic and hemodynamically stable	Stable Pulmonary Embolus without hemodynamic instability	Febrile without shock
Chronic stable atrial fibrillation	Chronic PACs /PVCs	Chronic Hemodialysis
Respiratory Illness: pneumonia, asthma or COPD without underlying cardiac	History of implanted pacemaker or AICD without evidence of malfunction or	Anemia not requiring a transfusion

Adapted from Patel & Dowling, 2016 and Sandau et al., 2017. Reviewed by Dr. Gregg Fonarow, University of California Los Angeles, Cardiology, 2019

Appendix G: Frequently Asked Questions

FAQs

Question	Response	Policy
What about patients on **ketamine** drips?	Use AHA Practice standards for ECG monitoring and monitor VS per policy	Use of Low Dose Ketamine, HS 1424
What about patients with **epidural analgesia or PCEA**?	Use AHA Practice standards for ECG monitoring and monitor VS per policy. Pulse ox monitoring in high risk patients.	Epidural Analgesia/ PCEA: Patient Controlled Epidural Analgesia, Nur-HS G1006.1
What about patients with **PCAs?**	Use AHA Practice standards for ECG monitoring and monitor VS per policy. Pulse ox monitoring in high risk patients.	Patient Controlled Analgesia (PCA), Nur-HS 171

Appendix H: Healthcare Technology Foundation Alarm Survey

Thank you for participating in the 2016 Healthcare Technology Foundation (HTF) clinical alarms survey of healthcare personnel. This important survey will update the HTF national surveys completed by 1,327 individuals in 2006 and by 4,278 in 2011 to determine changes in the perception of clinical alarm-related issues, event occurrence, improvement measures, and the priority for action.

This survey has two sections: A. Work-related demographics and B. Alarm-related information, with a total of 37 multiple choice and free-text questions. Please base your answers to questions on your own experience. It should take you no more than 15 minutes to complete the survey.

Participation in this study is completely voluntary. This anonymous Survey Monkey® survey does not track participant information or IP address. No identifiable information will be obtained.

You should not expect any direct benefit as a result of participating in this research, and you will not be compensated for your participation. The results of this survey will help to inform the healthcare community about the current status of issues related to clinical alarms and perhaps provide ideas for targeted areas for improvement.

A. WORK-RELATED DEMOGRAPHICS

1. Facility Type:Facility Type:

- ○ Acute Care Hospital
- ○ Ambulatory Care Facility or Surgery Center
- ○ Home Care
- ○ Long-term Care/Nursing Home
- ○ Other (please specify)

2. Hospital department (if applicable):

- ○ ICU
- ○ Progressive Care/Telemetry Unit
- ○ Emergency Department
- ○ OR/Anesthesia
- ○ Labor/Birth
- ○ Nursery
- ○ Respiratory Care
- ○ General Care Area
- ○ Risk/Safety Management
- ○ Support Services

- Healthcare Technology Management/Clinical Engineering
- Other (please specify)

3. Job title:

- RN
- LPN
- Respiratory Therapist
- Physician
- Nurse's Aide or Orderly
- Paramedical e.g. Radiology/Laboratory/Pharmacy
- Monitor Watcher
- Information Technology
- Clinical Engineer
- BMET
- Other (please specify)

4. Are you a manager or administrator?

- Yes
- No

5. Number of years of healthcare experience:

B. ALARM-RELATED INFORMATION

The remaining questions elicit alarm-related information and your opinions. These questions are divided into seven groups, with a box for your comments at the end of each group of questions. There is also an opportunity for you to provide general comments at the end of the survey.

GROUP 1: Nuisance Alarms

Nuisance alarms include both false and non-actionable alarms. False alarms occur when there is no valid triggering event, whereas non-actionable alarms correctly sound, but for an event for which no clinical intervention or action would be taken.

6. Nuisance alarms occur frequently:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

7. Nuisance alarms disrupt patient care:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

8. Nuisance alarms reduce trust in alarms and cause care givers to inappropriately turn alarms off at times other than during setup or procedures:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

9. Comments regarding Nuisance Alarms:

GROUP 2: Experience with Alarm Systems

10. Properly setting alarm parameters and alerts is overly complex in existing devices:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

11. Newer monitoring systems (e.g., less than three years old) have solved most of the previous problems we experienced with clinical alarms:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

12. The alarms used on my floor/area of the hospital are adequate to alert staff of potential or actual changes in a patient's condition:

- Strongly agree
- Agree
- Neutral

- Disagree
- Strongly disagree

13. There have been frequent instances where alarms could not be heard and were missed:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

14. Clinical staff is sensitive to alarms and responds quickly:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

15. When a number of devices are used with a patient, it can be confusing to determine which device is in an alarm condition:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

16. Background noise has interfered with alarm recognition:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

17. Comments regarding Experience with Alarm Systems:

GROUP 3: Alarm Notification

18. Does your hospital use alarm notification systems such as pagers, cell phones, or other wireless devices to communicate alarm conditions?

- Yes
- No

○ Not sure

19. Alarm integration and communication systems using pagers, cell phones, or other wireless devices are useful for improving alarm management and response:

○ Strongly agree

○ Agree

○ Neutral

○ Disagree

○ Strongly disagree

20. Does your institution use "monitor watchers" in a central viewing area to observe and communicate alarm conditions to caregivers?

○ Yes

○ No

○ Not sure

21. Central alarm management staff ("monitor watchers") responsible for receiving alarm messages and alerting appropriate staff is helpful:

○ Strongly agree

○ Agree

○ Neutral

○ Disagree

○ Strongly disagree

22. Comments regarding Alarm Notification:

GROUP 4: Smart Alarms

23. Does your institution use systems that employ smart alarms (e.g., where multiple parameters, rate of change of parameters, and signal quality, are automatically assessed in their entirety)?

○ Yes

○ No

○ Not sure

24. Smart alarms (e.g., where multiple parameters, rate of change of parameters, and signal quality, are automatically assessed in their entirety) would be effective to use for reducing false alarms:

○ Strongly agree

○ Agree

○ Neutral

- Disagree
- Strongly disagree

25. Smart alarms (e.g., where multiple parameters, rate of change of parameters, and signal quality, are automatically assessed in their entirety) would be effective to use for improving clinical response to important patient alarms:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

26. Comments regarding Smart Alarms:

GROUP 5: Institutional Requirements

27. If you are responsible for clinical alarms, have you been educated on the purpose and proper operation of alarm systems?

- Yes
- No
- Not sure

28. Is there a requirement in your institution/unit to document that the alarms are set and are appropriate for each patient?

- Yes
- No
- No sure

29. Clinical policies and procedures regarding alarm management are effectively used in my facility:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

30. Comments regarding Institutional Requirements:

GROUP 6: Clinical Alarms Management Improvements

31. Has your institution developed clinical alarm improvement initiatives over the past two years (e.g. policies and procedures, education, special projects, new technology)?

- Yes
- No
- Not sure

32. Has your institution instituted new technological solutions to improve clinical alarm safety?

- Yes
- No
- Not sure

33. Comments regarding Clinical Alarms Management Improvements:

GROUP 7: Adverse Events

34. Has your institution experienced adverse patient events in the last two years related to clinical alarm problems?

- Yes
- No
- Not sure

35. The Joint Commission's National Patient Safety Goal on Alarm Management that became effective in 2014 has reduced adverse patient events:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

36. Comments regarding Adverse Events:

37. General Comments:

Appendix I: Approval to use Healthcare Technology Alarm Survey

RE: Request to use National Clinical Alarm Survey

Ott, Jennifer C <Jennifer.Ott2@Mercy.Net>
Tue 8/6, 12:44 PM
Lehuquet, Cheryl Diane

Reply

Inbox

2016 HTF Clinical Alarm...
178 KB

Show all 1 attachments (178 KB) Download Save to OneDrive - UCLA Health Sciences

Dear Cheryl,

Thank you for the donation and submitted form. Please find attached the questions in Word format for the 2016 survey. Let me know if you have any further questions.

We would love to hear more about your results. We work closely with the AAMI HTSI group in alarm education and your project may be a great fit for future education of other facilities. Good luck!

Jennifer C. Ott, CCE, FACCE
Secretary / Treasurer
HTF Healthcare Technology Foundation
www.thehtf.org
C. 314.800.8565

References

Allan, S. H. (2018). Nurse perception of alarm fatigue impacts compliance with alarm management. *American Nurse Today*, *13*(5), 26–28. https://www.americannursetoday.com

Alsaad, A. A., Alman, C. R., Thompson, K. M., Park, S. H., Monteau, R. E., & Maniaci, M. I. (2017). A multidisciplinary approach to reducing alarm fatigue and cost through appropriate use of cardiac telemetry. *Postgraduate Medical Journal*, *93*(1101), 430–435. https://doi.org/10.1136/postgradmedj-2016-13476410.1136/postgradmedj-2016-134764

American Association of Colleges of Nursing. (2006). *The essentials of doctoral education for advanced nursing practice*. https://www.aacnnursing.org/Portals/42/Publications/DNPEssentials.pdf

American Association of Critical Care Nurses. (2018). *Practice alert outlines alarm management strategies*. AACN. https://www.aacn.org/newsroom/practice-alert-outlines-alarm-management-strategies

American College of Radiology. (n.d.). *Quality payment program and MIPS*. Practice management, quality and informatics. https://www.acr.org/Practice-Management-Quality-Informatics/Medicare-Value-Based-Programs/QPP

American Society for Microbiology. (2020, October 18). *CMS Final Rule on Antibiotic Stewardship Programs*. Policy. https://www.asm.org/Articles/Policy/CMS-Final-Rule-on-Antibiotic-Stewardship-Programs

Association for the Advancement of Medical Instrumentation. (2015). *Clinical alarm management compendium*. http://s3.amazonaws.com/rdcmsaami/files/production/public/FileDownloads/HTSI/Alarms/Alarm_Compendium_2015.pdf

Benjamin, E. M., Klugman, R. A., Luckmann, R., Fairchild, D. G., & Abookire, S. A. (2013). Impact of cardiac telemetry on patient safety and cost. *The American Journal of Managed Care*, *19*(6), e225–e232. Retrieved October 16, 2019, from https://www.ajmc.com

Bodenheimer, T., & Sinsky, C. (2014). From triple to quadruple aim: Care of the patient requires care of the provider. *Annals of Family Medicine*, *12*, 573–576. https://doi.org/10.1370/afm.1713

Brug, A. M., Hudson, K. M., Moore, R., & Chakraborti, C. (2018). Choosing telemetry wisely: A survey of awareness and physician decision-making regarding AHA telemetry practice standards. *Journal of General Internal Medicine*, *34*(4), 496–497. https://doi.org/10.107/s11606-018-4769-z

Bubb, C. (2011). A timely practice: A nurse-driven telemetry discontinuation protocol. *The Pennsylvania Nurse*, *66*(4), 6–10. https://www.ncbi.nlm.nih.gov/pubmed/22359965

Bulger, J., Nickel, W., Messler, J., Goldstein, J., O'Callaghan, J., Auron, M., & Gulati, M. (2013). Choosing wisely in adult hospital medicine: Five opportunities for improved healthcare value. *Journal of Hospital Medicine*, *9(9)*, 486–492. https://doi.org/10.1002/jhm.2063

Cabana, M. D., Rand, C. S., Powe, N. R., Wu, A. W., Wilson, M. H., Abboud, P. C., & Rubin, H. R. (1999). Why don't physicians follow clinical practice guidelines?. *Journal of the American Medical Association*, *282*(15), 1458–1465. https://doi.org/10.1001/jama.282.15.1458

Careerbuilder. (2013, April 30). *More than one third of employed healthcare workers plan to look for a new job this year, CareerBuillder health care study reveals* [Press release]. https://www.careerbuilder.com/share/aboutus/pressreleasesdetail.aspx?sd=4%2f30%2f2013&id=pr754&ed=12%2f31%2f2013

Chen, S., Palchaudhuri, S., Johnson, A., Trost, J., Pomor, I., & Zakaria, S. (2017). Does this patient need telemetry? An analysis of telemetry ordering practices at an academic medical center. *Journal of Evaluation in Clinical Practice*, *23*(4), 741–746. https://doi.org/10.1111/jep.12708

Chism, L. A. (2019). *The Doctor of Nursng Practice. A guidebook for role development and professional issues* (4th ed.). Jones & Bartlett.

Chong-Yik, R., Bennett, A. L., Milani, R. V., & Morin, D. P. (2018). Cost-saving opportunities with appropriate utilization of cardiac telemetry. *The American Journal of Cardiology*, *122*(9), 1570–1573. https://doi.org/10.1016/j.amjcard.2018.07.016

Clark, T. (2016, June 5). *HTF Update: 2016 National Clinical Alarm Survey Results* [Conference session]. AAMI 2016, Tampa, FL, United States. thehtf.org/documents/2016%20National%20Clinical%20Alarms%20Survey%20Results.pdf

Cvach, M. (2012). Monitor alarm fatigue: An integrative review. *Biomedical Instrumentation & Technology*, *46*, 268–277. https://doi.org/10.2345/0899-8205-46.4.268

Department of Nursing UCLA Health. (2018). *Education and Cerification Report*.

DeVon, H. A., Block, M. E., Moyle-Wright, P., Ernst, D. M., Lazzara, S. J., Savoy, S. M., & Kostas-Polston, E. (2007). A psychometric toolbox for testing validity and reliability.

Journal of Nursing Scholarship, *39*(2), 155–164. https://doi.org/doi:10.1111/j.1547-5069.2007.00161.x

Dressler, R., Dryer, M. M., Coletti, C., Mahoney, D., & Doorey, A. J. (2014). Altering overuse of cardiac telemetry in non-intensive care settings by hardwiring the use of American Heart Association guidelines. *Journal of the American Medical Association Internal Medicine*, *174*(11), 1852–1854. https://doi.org/10.1001/jamainternmed.2014.4491.

Drew, B. J., Califf, R. M., Funk, M., Kaufman, E. S., Krucoff, M. J., Laks, M. M., Macfarlane, P. W., Sommargren, C., & Van Hare, G. F. (2004). Practice standards for electrocardiographic monitoring in hospital settings: An American Heart Association scientific statement from the Councils on Cardiovascular Nursing, Clinical Cardiology, and Cardiovascular Disease in the Young: Endorsed by the International Society of Computerized Electrocardiology and the American Association of Critical-Care Nurses. *Circulation: Cardiovascular Quality and Outcomes*, *110*, 2721–2746. https://doi.org/10.116/01.CIR.0000145144.56673.59

Durban, C. G. (2016). Physiologic monitoring: Improving safety or increasing risk?. *Respiratory Care*, *61*, 1110–1121. https://doi.org/10.4187/respcare.04931

Edholm, K., Kukhareva, P., Clarkowski, C., Carr, J., Gill, D., Rupp, A., Morshedzadeh, J., Wanner, N., & Kawamoto, K. (2018). Decrease in inpatient telemetry utilization through a system-wide electronic health record change and a multifaceted hospitalist intervention. *Journal of Hospital Medicine*, *13*(8), 531–536. https://doi.org/10.12788/jhm.2933

Edworthy, J. (2013). Medical audible alarms: A review. *Journal of the American Medical Informatics Association*, *20*(3), 584–589. https://doi.org/10.1136/amiajnl-2012-001061

Emergency Care Research Institute. (2014). *Top 10 health technology hazards for 2014: Key safety threats to manage in the coming year*. https://www.ecri.org/library/general-topics/alarm-management

Emergency Care Research Institute. (2017). *Making alarm management a patient safety priority*. ECRI. Retrieved August 4, 2019, from https://www.ecri.org/Resources/Alarm_Safety_Handbook/ECRI_Institute_Alarm_Safety_Handbook_Contents.pdf

Falun, N., Nordrehaug, J. E., Hoff, P. I., Langorgen, J., Moons, P., & Norekval, T. M. (2013). Evaluation of the appropriateness and outcome of in-hospital telemetry monitoring. *American Journal of Cardiology*, *112*, 1219–1223. https://doi.org/10.1016/j.amjcard.2013.05.069

Funk, M., Fennie, K. P., Stephens, K. E., May, J. L., Winkler, C. G., & Drew, B. J. (2018). Association of implementation of practice standards for electrocardiographic monitoring with nurses' knowledge, quality of care, and patient outcomes: Findings from the Practical Use of the Latest Standards of Electrocardiography (PULSE) trial. *Circulation: Cardiovascular Quality Outcomes*, *10*(2), 1–21. https://doi.org/10.1161/CIRCOUTCOMES.116.003132

Grimley, K., & Branom, R. (2019). *The UCLA way to wellness. Promoting optimal patient health and well-being in the acute care setting* [Conference Session]. UCLA Health, Los Angeles, CA, United States.

Headley, M. (2017). Nurses drive change in patient safety projects. *Patient Safety & Quality Healthcare*. https://www.psqh.com/analysis/nurses-drive-change-in-patient-safety-improvements/

Healthcare Technology Foundation Clinical Alarms Survey of Healthcare Personnel. (2016). (Survey) [Apparatus]. http://thehtf.org

Healthcare Technology Foundation. (n.d.). *Clinical alarm hazards and management*. Retrieved June 23, 2019, from http://www.thehtf.org/clinical.asp

Heath, C., & Heath, D. (2007). *Made to stick: Why some ideas survive and others die*. Random House. Amazon Audible

Institute for Healthcare Improvement. (2020). *IHI Triple Aim Initiative*. IHI. http://www.ihi.org/Engage/Initiatives/TripleAim/Pages/default.aspx

Ivanye, C., Ohuabuhwa, C., Henriques-Forsythe, M., Uma, J., Kemilembe Kamigisha, L., Olejeme, K., & Onwuanyi, A. (2010). Evaluation of telemetry utilization, policy and outcomes in an inner-city academic medical center. *Journal of the National Medical Association*, *102 (7)*, 598–604. https://doi.org/10.1016/S0027-9684(15)30637-4

Knowles, M. S. (1978). Andragogy: adult learning in perspective. *Sage Journals*, 9–20. https://doi.org/10.1177/009155217800500302

Lewis, C. L., & Oster, C. A. (2019). Research outcomes of implementing CEASE. *Dimensions of Critical Care Nursing*, *38*(3), 160–173. https://doi.org/10.1097/DCC.0000000000000357

Melnyk, B., & Morrison-Beedy, D. (Eds.). (2019). *Intervention research and evidence-based quality improvement* (2nd ed.). Springer.

Najafi, N., Cucina, R., Pierre, B., & Khanna, R. (2019). Assessment of a targeted electronic health record intervention to reduce telemetry duration: A cluster-randomized clinical trial. *Journal of the American Medical Association Internal Medicine*, *179*(1), 11–15. https://doi.org/10.1001/jamainternmed.2018.5859

Neuman, B. (1982). *The Neuman systems model*. Appleton-Century-Crofts.

Neuman, B. (2002). The Neuman Systems Model. In B. Neuman & J. Fawcett (Eds.), *The Neuman Systems Model* (4th ed., pp. 3–33). Prentice Hall.

Patel, S., De Silva, S., & Dowling, E. (2017). Physicians are often incorrect about the telemetry status of their patients. *Journal of Hospital Medicine*, *12*(1), 40–41. https://www.journalofhospitalmedicine.com

Patel, S., Sim, M. S., & Dowling, E. (2016). *Decreasing inappropriate use of cardiac telemetry* [Unpublished manuscript]. Department of Medicine, UCLA. https://proceedings.med.ucla.edu/index.php/2016/08/30/decreasing-inappropriate-use-of-cardiac-telemetry/

Pelter, M. M., Stotts, J., Spolini, K., Nguyen, J., Sin, E., & Hu, X. (2017). Developing a clinical alarms management committee at an academic medical center. *Biomedical Instrumentation and Technology*, *51*(s1), 21–29. https://doi.org/10.2345/0899-8205-51.s2.21

Perrin, K., Ernst, N., Nelson, T., Sawyer, M., Pfoh, E., & Cvach, M. (2016). Effect of a nurse-managed telemetry discontinuation protocol on monitoring duration, alarm frequency and adverse patient events. *Journal of Nursing Care Quality*, *32*(2), 126–133. https://doi.org/10.1097/NCQ.0000000000000230

Philips. (2018). *Alarm Report* (Data file Rev B) [Data set].

Phillips, J., Polomano, R. C., Lerning-Lee, T., & Davis Crutcher, T. (2019). Evaluation of telemetry utilization on Medical-Surgical Units. *Nursing Clinics of North America*, *54*(1), 97–114. https://doi.org/10.1016/j.cnur.2018.10.001

Potluri, A., Kudaravalli, M., Defail, A., Prabhakaran, D., Reilly, J. B., & Kapetanos, A. (2017, March 31). Abstract 173: Simple guidance improves appropriate telemetry utilization. *Circulation: Cardiovascular Quality and Outcomes*. https://doi.org/doi/10.1161/circoutcomes.10.suppl_3.173

Rayo, M. F., Mansfield, J., Eiferman, D., Mignery, T., White, S., & Moffatt-Bruce, S. D. (2015). Implementing an institution-wide quality improvement policy to ensure appropriate use of continuous cardiac monitoring: a mixed-methods retrospective data analysis and direct observation study. *BMJ Quality and Safety*, *10*, 796–802. https://doi.org/10.1136/bmjqs-2015-004137

Sandau, K. E., Funk, M., Auerbach, A., Barsness, G. W., Blum, K., Cvach, M., Lampert, R., May, J. L., McDaniel, G. M., Perez, M. V., Sendelbach, S., Sommargren, C. E., & Wang, P. J. (2017). Update to practice standards for electrocardiographic monitoring in hospital settings: A scientific statement from the American Heart Association. *Circulation*, *136*, e273–e344. https://doi.org/10.1161/CIR.0000000000000527

Schachter, J. L., & Gopalakrishnan, P. (2019). Telemetry: Do you have the heart not to order it. *Journal of the American College of Cardiology*, *73*(Supplement 1). https://doi.org/10.1016/S0735-1097(19)33642-3

Schlant, R. C., Adolph, R. J., DiMarco, J. P., Dreifus, L. S., Dunn, M. I., Fisch, C., Garson, A., Haywood, L. J., Levine, H. J., Murray, J. A., Noble, R. J., & Ronan, J. A. (1992). Guidelines for electrocardiography: A report for the American College of Cardiology/ American Heart Association task force on assessment of diagnostic and therapeutic cardiovascular procedures (Committee on Electrocardiolography). *Journal of the American College of Cardiology*, *19*(3), 473–481. http://www.onlinejacc.org

Sendelbach, S., Sandau, K. E., Smith, L., Krieger, R., Hanovich, S., & Funk, M. (2019). Implementing practice standards for inpatient electrocardiographic monitoring. *American Journal of Critical Care*, *28*(2), 109–116. https://doi.org/10.4037/ajcc2019699

Stetler, C. B. (2001). Updating the Stetler model of research utilization to facilitate evidence-based practice. *Nursing Outlook*, *49*, 272–279. https://doi.org/10.1067/mno.2001.120517

Stolzfus, K. B., Bhakta, M., Shankweiler, C., Mount, R. R., & Gibson, C. (2019). Appropriate ultilisation of cardiac telemetry monitoring: A quality inprovement project. *BMJ Open Quality*, *8*(2). https://doi.org/10.1136/bmjoq-2018-000560

Strout, K. (2012). Wellness promotion and the Institute of Medicine's Future of Nursing ReportAre nurses ready?. *Holistic Nursing Practice*, 129–136. https://doi.org/10.1097/HNP.0b013e31824ef581

Svec, D., Ahuja, N., Evans, K. H., Horn, J., Garg, T., Loftus, P., & Shieh, L. (2015). Hospitalist intervention for appropriate use of telemetry reduces length of stay and cost. *Journal of Hospital Medicine*, *10*(9), 627–632. https://doi.org/10.1002/jhm.2411

Telemetry. (2019). In *Wikipedia*. Retrieved October 8, 2019, from https://en.wikipedia.org/wiki/Telemetryhttps://en.wikipedia.org/wiki/Telemetry

The Joint Commission. (2013). *The Joint Commission Sentinel Event Alert: Medical device alarm safety in hospitals* [Newsletter]. https://www.pwrnewmedia.com/2013/joint_commission/medical_alarm_safety/downloads/SEA_50_alarms.pdf

The Joint Commission. (2014, November 13). *Sentinal event alert: Safe use of opioids in hospitals*. Providers Clinical Support System. https://pcssnow.org/resource/joint-commission-sentinel-event-alert-safe-use-opioids-hospitals/

The Joint Commission. (2019). *National Patient Safety Goals Effective January 2019*. https://www.jointcommission.org/assets/1/6/NPSG_Chapter_HAP_Jan2019.pdf

World Health Organization. (2019). *Health technology assessment*. Retrieved October 8, 2019, from https://www.who.int/health-technology-assessment/en/

Zadvinskis, I. M., Schweitzer, K., Murry, T., & Wood, T. (2018). Tele talks: Nurse-led discussions regarding need and duration of cardiac telemetry may impact alarm fatigue, empower nurses, and reduce cost. *Worldviews on Evidence-Based Nursing*, *15*(4), 323–325. https://doi.org/10.1111/wvn.12294