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Implementing use of the MOSS (Michigan Opioid Safety Score) Tool and Interventions to reduce Opioid-Related Overdose Events in High Risk Patients

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Abstract

Opioids are among the most common pharmacological class of therapeutic medications prescribed to alleviate pain across all healthcare settings. However, opioid-related adverse events are a growing problem contributing to an increase in morbidity and mortality. Current hospital practice does not utilize a pre-opioid administration screening tool to assess patient risk of adverse events related to opioid administration. The implementation of the Michigan Opioid Safety Score (MOSS), an evidence-based risk assessment tool which utilizes patient characteristics as well as respiratory assessment for the prediction and early detection of opioid-induced adverse events. This quality improvement project evaluated the effectiveness of the MOSS in detecting opioid-induced adverse events prior to the need for naloxone. The MOSS was applied to hospitalized patients that experienced an opioid-induced adverse event which required the use of naloxone to determine if the safety score would have detected an adverse event prior to current practices. The main finding from the retrospective chart audit identified that POSS in conjunction with MOSS identifies more patients as at risk for an opioid-related adverse event than POSS alone, suggesting it would be beneficial to incorporate the MOSS into its screening process in order to reduce opioid-related adverse events. A secondary finding identified that scoring unsafe on the risk factors of snoring and abdominal and/or thoracic surgery on the MOSS were most commonly associated with an opioid-induced adverse event, suggesting that patients with these risk factors may need increased monitoring practices and equipment support, such as capnography and the use of BiPAP or CPAP.

Keywords: opioid, capnography, respiratory depression, end tidal CO2, sedation, monitoring

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Implementing use of the MOSS (Michigan Opioid Safety Score) Tool and Interventions to reduce Opioid-Related Overdose Events in High Risk Patients

Pain, an unpleasant sensory and emotional experience associated with actual or potential tissue damage, is the most common reason people in the United States (US) seek healthcare (National Institutes of Health, 2018; Treede, 2018). Opioids are among the most common pharmacological class of therapeutic medications prescribed to alleviate pain across all healthcare settings (National Center for Health Statistics, 2017). Although opioids are standard treatment to assure patient comfort, there are many side effects, ranging from nausea and vomiting to over-sedation and respiratory depression.

In addition to the reduction of opioid prescribing and efforts to increase multimodal pain management modalities, The Joint Commission (TJC) has highlighted the importance of increased screening and respiratory assessment within the population prescribed and administered opioids (2012). According to TJC Sentinel Event database (2004-2011), 29% of the opioid-related adverse drug mortality events were related to improper monitoring of a patient. In response, TJC identified a need for organizations to increase staff awareness of factors which increase likelihood of accidental opioid over-use, over-sedation, and respiratory depression to avoid adverse patient outcomes.

Not all hospitals utilize a pre-opioid administration screening tool to assess patient risk of adverse events related to opioid administration. A screening tool such as the Pasero Opioid-Induced Sedation Scale (POSS) and the Richmond Agitation and Sedation Scale are utilized for assessing a patient's level of sedation and arousal in the moment (Soto & Yaldou, 2015). Present standard respiratory assessment entails pulse oximetry combined with respiratory assessment via observation or auscultation, which has been shown to be less accurate than capnography

combined with respiratory assessment (Adams, Butas, & Spurlock, 2015; Cacho, Perez-Calle, Barbado, Lledo, Ojea, & Fernandez-Rodriguez, 2010; Deitch, Miner, Chudnofsky, Dominici, & Latta, 2010; Hutchison & Rodriguez, 2008). Both practices, retrospective assessment of opioid-related adverse effects and in-the-moment respiratory assessment, are suboptimal for a patient at increased risk of opioid related respiratory depression. It is imperative that hospitals institute proactive screening tools and evidence-based monitoring to prevent opioid related adverse outcomes such as respiratory depression and death. The purpose of this quality improvement project was to evaluate the effectiveness of the Michigan Opioid Safety Score (MOSS), a risk assessment tool, to detect opioid-induced adverse events prior to the need for naloxone in a heart center in a Midwest hospital (HRT). MOSS is an evidence-based risk assessment tool which utilizes patient characteristics as well as respiratory assessment for the prediction and early detection of opioid-induced adverse events.

Assessment of the Organizational

An organizational assessment (OA) utilizes a systematic approach to evaluate the workflow and factors which impact the performance of an organization (Reflect & Learn, n.d.). An OA aids in determining areas of strength and weakness within the organization. This assessment analyzed HRT using a framework, to identify key stakeholders, as well as the strengths, weaknesses, opportunities, and threats (SWOT) of the organization through a SWOT analysis.

Framework for Assessment

The Canadian Foundation for Healthcare Improvement (CFHI) assessment tool evaluates an organization’s capability for change, strengths for implementing change, and potential for growth (CFHI, 2014). Six core principles aimed at improving healthcare guide CFHI. These

principles are patient-centered and population-based care, evidence-based decision making, engaging a wide range of stakeholders, engaging participation from managers and providers, using an incremental process for large scale improvements, and viewing improvement as a collective learning process (CFHI, 2014). Appendix A is a visual representation of how the principles interact in order to improve healthcare (adapted from CFHI, 2018). The key purpose for utilizing the CFHI assessment tool within the organization was to analyze how effectively the six principles were exhibited to formulate suggestions for improvements.

The CFHI assessment tool emphasizes the collaboration from all levels within a system, including policy, organizational, clinical, and front-line staff as important factors for successful healthcare delivery (CFHI, 2014). CFHI highlights the importance of change cycles for improvement to maintain stability within the organization. Lastly, CFHI holds the belief that change within a level of a health system can transcend to the clinical level and affect patient health outcomes and satisfaction (CFHI, 2014).

Ethics and Protection of Human Subjects

The HRT and the GVSU Institutional Review Board (IRB) determined the project to be quality improvement (see Appendix B and C).

Stakeholders

Key stakeholders are individuals who affect or are affected by changes within an organization and are, therefore, either actively or passively impacted by changes in actions, objectives, or policies within an organization (Moran, Burson, & Conrad, 2017). The key stakeholders involved in the implementation of an opioid-induced adverse event risk screening tool, known as the MOSS within HRT, included healthcare providers, such as physicians, advanced practice providers, fellows, hospitalists, residents, and nurses. Patients were also an

important stakeholder, since patient safety and outcomes are impacted by changes in policy, procedure, and practices within an organization. Additional stakeholders include the Pain Management and Opioid Prescribing Pain Committee at HRT and the information technologists (IT) who would implement the MOSS screening tool into the electronic health record (EHR). Lastly, HRT as an organization, was an important key stakeholder. It is important to have buy-in for the implementation of the MOSS from HRT, as there will be associated cost purchasing equipment such as capnography as well as education of staff on the use of the MOSS.

SWOT

A SWOT analysis is a tool used to analyze a phenomenon of interest by assessing its strengths, weaknesses, opportunities, and threats (Moran et al., 2017). Internal analysis includes identifying an organizations beneficial attributes (strengths) and perceived short-comings or failures (weaknesses). External analysis includes evaluating threats to an organization's success within the environment and identifying possible opportunities for growth or expansion within an organization (Moran et al., 2017). A SWOT analysis determined the strengths, weaknesses, opportunities, and threats to implementing the MOSS risk assessment (see Appendix D).

Strengths. One strength was the interest in improving opioid practices and patient safety within the Pain Management and Opioid Prescribing Steering Committee and MOSS sub-committee. Another strength was that the MOSS is available within the current EHR without the need for purchase and can easily be installed. Lastly, there was work surrounding issues related to opioids. As such, investing time and money into MOSS was viewed more favorably at this time due to its added benefit of meeting TJC standards for accredited hospitals, such as minimizing risks associated with opioid use (2018).

Weaknesses. A weakness of HRT was the current assessment tool. The POSS currently used assessed an individual's level of alertness in the moment and failed to identify risk of an opioid related adverse event.

Opportunities. At HRT there was opportunity to be one of the first organizations in the Midwest to utilize the MOSS. As such, HRT had the opportunity to be at the forefront of changes in healthcare, taking a proactive role in preventing unnecessary morbidity and mortality related to opioid use. Another opportunity was improving staff education on patient risk factors for opioid induced adverse outcomes and empower staff to care for this population.

Threats. A threat to HRT was that, without addressing TJC standards, the hospital risks loss of Magnet® status and accreditation. As previously discussed, one of TJC standards is to "actively engage medical staff and hospital leadership in improving pain assessment and management, including strategies to decrease opioid use and minimize risks associated with opioid use" (TJC, 2018, p. 1). Loss of accreditation would result in a financial loss and damage to the organization's reputation.

Clinical Practice Question

The following clinical questions were answered: "Does the MOSS, in conjunction with the POSS, detect the opioid-induced adverse event of respiratory depression more effectively when compared to the POSS alone?", as well as, "Does the use of capnography and assessment of respiratory movement, as indicated by the MOSS for opioid-induced sedation, more efficaciously and accurately detect opioid-induced respiratory depression events compared to assessment of respiratory movements and monitoring with pulse oximetry?"

Review of the Literature

Due to the current lack of randomized-controlled trials on use of the MOSS, the literature review answered the question: “Does the use of capnography and assessment of respiratory movement, as indicated by the MOSS for opioid-induced sedation, more efficaciously and accurately detect opioid-induced respiratory depression events compared to assessment of respiratory movements and monitoring with pulse oximetry?”

Method

Search methods. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline served as the framework for this review (Moher, Liberati, Tetzlaff, Altman, & PRISMA Group, 2009). A comprehensive search was conducted in the CINAHL, PubMed, and Medline database limited to English language during 2008 to 2018. Keywords were opioid, capnography, and respiratory depression. Similar search terms, end tidal CO2, sedation, and monitoring were listed by using Boolean operator OR, and the Boolean operator AND was used to narrow articles that were relevant to the review.

Inclusion and Exclusion Criteria

Population. Included were articles that featured adults age 18 or older who underwent any procedure which necessitated sedation, such as colonoscopy and transesophageal echocardiogram (TEE), and compared the difference in detection time of respiratory depression between capnography and pulse oximetry. Excluded were articles that featured adults with chronic lung disease, such as chronic obstructive pulmonary disease, chronic oxygen requirements, patients on ventilators, and patients in respiratory distress prior to sedation.

Intervention. Randomized controlled trials that involved pulse oximetry as the control and capnography as the primary intervention for assess respiratory depression were included.

Articles that did not utilize and compare both capnography and pulse oximetry to evaluate for respiratory depression were excluded.

Comparison. Articles that were selected compared capnography to pulse oximetry. Excluded were articles that used equipment other than pulse oximetry and capnography to monitor respiratory status.

Outcome. Included were outcomes on the efficacy of capnography in detecting respiratory depression compared to pulse oximetry. Excluded were outcomes involving the comparison of other means of assessing respiratory function other than capnography and pulse oximetry.

Search Outcomes

The search yielded a total of 168 articles. One hundred duplicates were removed. Each review was screened using inclusion and exclusion criteria according to PRISMA criteria, eliminating 54 articles (Moher et al., 2009). Review of titles and abstracts resulted in removal of 10 articles that did not meet the inclusion criteria. The remaining four articles were included in this review (see Appendix E).

Summary of Results

Four articles met the inclusion criteria and were included (see Appendix F). All studies were randomized controlled trials comparing the efficacy of capnography to pulse oximetry in detecting respiratory depression in the procedural and post-procedural population. Respiratory depression definitions slightly varied between the four studies included. The parameters for respiratory depression were an SpO2 of 88-93%, end-tidal CO_2 level greater than 50-60 mmHg, an $ETCO_2$ change from baseline greater than 10 mmHg, or loss of $ETCO_2$ waveform for greater than or equal to 15 seconds.

Study characteristics. Articles included were randomized control trials comparing capnography and pulse oximetry for the detection of respiratory depression in patients undergoing procedures requiring sedation such as a TEE and colonoscopy. All articles were obtained from peer-reviewed journals. Population samples within the four studies utilized varied from 50-200 participants. All patients were at least 18 years of age or older. In all four studies, no statistically significant differences in patient demographic characteristics was observed. Assessment of respiratory function and detection of respiratory decline was monitored during and after sedation in various hospital settings, such as the emergency department and endoscopy department, for various procedures, such as TEE, colonoscopy, and orthopedic surgeries.

Intervention and comparison characteristics. Capnography was compared to pulse oximetry in all studies. All studies compared the efficacy of capnography to pulse oximetry. Two of the studies utilized pulse oximetry with blinded capnography versus capnography alone (Adams, Butas, & Spurlock, 2015; Deitch, Miner, Chudnofsky, Dominici, & Latta, 2010). The other two studies compared capnography alone versus pulse oximetry alone (Cacho, Perez-Calle, Barbado, Lledo, Ojea, & Fernandez-Rodriguez, 2010) and capnography alone versus pulse oximetry combined with respiratory assessment via observation or auscultation (Hutchison & Rodriguez, 2008).

Measures. Respiratory depression was measured in all studies by reporting the number of detected events as outlined by the study guidelines and definitions of respiratory depression. Hutchinson and Rodriguez (2008) found that respiratory depression was defined as a respiratory rate of equal to or less than six breaths per minute, an apneic event lasting longer than 20 seconds, an end-tidal CO_2 level greater than 60 mmHg, or SPO_2 less than 88%. Respiratory depression in the study by Adams, Butas, and Spurlock (2015) defined respiratory depression as

an end-tidal CO_2 level of greater than or equal to 50 mmHg, an end-tidal CO_2 change from baseline greater than 10 mmHg, or a loss of end-tidal CO_2 waveform for greater than or equal to 15 seconds. Deitch et al. (2010) reported that respiratory depression was defined as an SPO_2 level of less than 93% for 15 seconds or greater, an $ETCO_2$ level of 50 mmHg or greater, an $ETCO_2$ increase or decrease from baseline of 10% or greater, or a loss of $ETCO_2$ waveform for 15 seconds or greater. Cacho et al. (2010) defined respiratory depression as a cessation of respiratory activity for 30 seconds or more, end-tidal CO_2 change from baseline greater than 25%, or an SpO_2 value less than 90%.

Efficacy of capnography. All four studies reported a statistically significant increase in detection of respiratory depression in the capnography group compared to the pulse oximetry group. Deitch et al. (2010) reported that 17 patients in the non-blinded capnography group and 27 patients in the blinded capnography group experienced respiratory depression with an SpO_2 level of less than or equal to 93%. Within the same study, more physician interventions occurred within the non-blinded capnography group to improve respiratory function (35%) versus the blinded capnography group (22%). In the study by Cacho et al. (2010), blinded capnography detected 29 episodes of respiratory depression in 16 patients, whereas pulse oximetry detected oxygen desaturation in only 38% of those episodes. Adams, Butas, and Spurlock (2015) reported that of the 90 patients who had respiratory depression based on $ETCO_2$ readings, SpO_2 at the time of respiratory depression was M=96.8%, with only 5 patients showing an SpO_2 of 91% or less. In the study by Hutchinson and Rodriguez (2008), a total of 146 episodes of respiratory depression were detected within the capnography group, whereas respiratory depression was detected in only six patients in the pulse oximetry group.

Evidence to be used for Project

Respiratory depression as a result of a procedure with sedation and analgesia is the primary cause of morbidity within the procedural and post-procedural population (Cacho et al., 2010; Deitch et al., 2010; Hutchinson & Rodriguez, 2008). Current practice for respiratory assessment prior to and after procedure includes basic respiratory monitoring using assessment of respiratory movements and monitoring with pulse oximetry (Cacho et al., 2010). Findings of this literature review suggest that capnography is more effective in detecting respiratory depression than pulse oximetry in the procedural and post-procedural population. In addition, two of the four studies in this review indicated physicians were more likely to intervene to reverse respiratory depression when capnography was used to assess respiratory status (Adams, Butas, & Spurlock, 2015; Deitch et al., 2010).

Phenomenon Conceptual Model

Conceptual models guided understanding of a phenomenon. The phenomenon of interest for this quality improvement project is opioid-induced adverse events, more specifically opioid-induced respiratory depression. A conceptual model that will be used to provide structure for this phenomenon of interest is Marion Good's Theory of Balance Between Analgesia and Side Effects (Good, 1998). The theory has three areas of nursing action to minimize pain as well as potential adverse events: multimodal therapy, attentive care, and patient participation (see Appendix G). The goal of Good's theory is to appropriately treat pain without the experience of side effects.

Multimodal therapy. The first area of the theory focuses on the nurse combining potent pain medications, such as opioids, with non-opioid pain medications and nonpharmacological therapies as adjuvants (Good, 1998). Potent pain medications are the major method of pain relief

utilized within the acute care setting, however, they are also the most likely to cause side effect. Non-opioid pharmacological adjuvants may be given safely along with potent pain medications to help alleviate pain symptoms because their unrelated mechanism of action increases relief while not compromising safety. Lastly, nonpharmacological adjuvants, such as relaxation techniques, heat and cold, repositioning, or music therapy, may be used to distract the patient from their pain and increase their comfort without any side effects. As explained by the first area of Good's theory (Good, 1998), utilizing non-opioid pharmacological adjuvant and nonpharmacological adjuvant therapies in combination with potent pain medications can decrease pain as well as minimize the risk of side effects.

Attentive care. The second area of the theory focuses the nurse's responsibility to regularly assess for pain and side effect, identify inadequate relief of pain and unacceptable side effects, and intervene based on assessment findings (Good, 1998). According to Good's theory (1998), nurses are responsible for utilizing both verbal and non-verbal reports of pain, treating the pain based on intensity and patient and situational characteristics, and reassessing the patient for relief of pain and side effects. In line with this theory, the purpose of this project is to implement the MOSS in order to increase provider ability to relieve pain symptoms and minimize risks of side effects through the use of regular assessment.

Patient participation. The final area of the theory focuses on the nurse establishing a relationship and goals with the patient in order to achieve the mutual goal of relief of pain symptoms without adverse side effect occurrence (Good, 1998). According to Good's theory (1998), the nurse is responsible for providing patient teaching about the causes of pain, modalities of pain relief, and potential side effects of interventions. The nurse should also

determine a mutual and realistic goal for pain relief with the patient. Patient participation is essential in achieving acceptable relief of pain symptoms and minimizing the risk of side effects.

Project Plan

Purpose of Project and Objectives

The goal of this project was to decrease the occurrence of opioid-induced adverse events using a risk assessment tool. The current tool used at HRT did not assess for patient characteristics which increase the risk of adverse event occurrence. Thus, this project examined if the MOSS detects opioid-induced adverse events of respiratory depression more effectively when combined with the POSS compared to the POSS alone.

Design for the Evidence-based Initiative

Quality improvement projects involve systematic activities designed to monitor, assess, and improve the quality of healthcare (Health Resources and Services Administration, 2011). This project focused on the retrospective application of the MOSS to determine if the MOSS is more effective at detecting risk of opioid-induced adverse events, specifically respiratory depression. The project also examined if the screening tool detects risk of opioid-induced adverse events, the MOSS will be applied retrospectively via chart audit to patient's that received naloxone to determine if the MOSS would have classified the patient as being at high risk for an adverse-opioid event, thus cueing the provider to intervene, preventing an adverse event.

Setting

The setting was a heart center in a Midwest hospital (HRT). The organization, HRT, is composed of nine floors with 162 beds. The floors range in acuity from intensive care units to progressive care units. Administrative approval obtained from the organization (see Appendix

B).

Participants

Patients that received naloxone within HRT between August 1st, 2018 to December 31st, 2018 were included.

Model Guiding Implementation

The model guiding implementation was the Institute for Healthcare Improvement (IHI) Plan Do Study Act (PDSA) cycle (see Appendix H). The PDSA model is useful for documenting and testing a proposed change (IHI, 2017).

Plan. The plan phase of PDSA includes stating a clinical question, predicting the outcome of a proposed intervention, developing a plan to test the practice change, and identifying what data needs to be collected (IHI, 2017). The predicted outcome was that the MOSS will identify patients at risk for opioid-induced adverse events and cue providers to intervene appropriately, ultimately reducing the number of opioid-induced adverse respiratory depressive events. The plan was to validate the risk assessment tool for opioid-induced respiratory events includes retrospectively applying the MOSS to patients administered naloxone.

Do. The do step of PDSA includes piloting the intervention on a small scale with data collection and analysis (IHI, 2017). A chart audit was performed of patients administered naloxone to determine the severity of the problem within HRT.

Study. During the study phase of PDSA, results are analyzed and compared to original predictions (IHI, 2017). The MOSS was applied to the patient's that were administered naloxone. Data were analyzed to determine if the MOSS is more sensitive in the detection of patients at risk for opioid-induced adverse events at HRT than the POSS.

Act. The final stage of PDSA entails the decision to adapt, adopt, or abandon the change before starting a new cycle in the plan phase of PDSA (IHI, 2017). Adapting the change involves making modifications and running another test. Adopting the change involves testing the change on a larger scale. Abandoning the change involves changing the idea altogether (IHI, 2017).

Implementation Steps and Strategies

According to Powell et al. (2015), there are evidenced-based implementation strategies used within the implementation of a project, including: readiness assessment and identifying barriers, capturing and sharing knowledge and creating a collaborative, and consultation and tools for quality improvement. Each will be discussed.

Readiness assessment and identifying barriers. An organizational assessment and SWOT analysis were completed in order to assess readiness for change as well as identify barriers (Powell et al., 2015). The assessment identified strategies for implementation.

Capturing and sharing knowledge and creating a collaborative. Strategies utilized included capturing and sharing knowledge, organizing implementation team meetings, and using an implementation advisor (Powell et al., 2015). Capturing and sharing knowledge are aspects of ongoing implementation strategies at HRT. HRT has a Pain Management and Opioid Prescribing Steering Committee as well as a MOSS subcommittee which advocate for and drive practice changes surrounding the safe use of opioids. These committees have chairs appointed, which oversee the implementation of practice change related to opioid prescribing and safety.

Consultation and tools for quality improvement. The project re-examined implementation, provided consultation, and developed tools for quality monitoring (Powell et al., 2015). Re-examining risk assessment strategies were completed to understand the severity of the opioid-induce adverse reaction rate at baseline. Consultation with HRT based on findings in

literature and naloxone events found through chart audits occurred. Retrospective application of the MOSS to patient's that had naloxone events in order to determine if MOSS is more sensitive in the detection of individuals at risk for opioid-induced adverse events than the POSS occurred and was reported to HRT.

Measures

Measures utilized for gauging the project success are shown in Appendix I. The measures that are necessary to determine the MOSS include assessing patient health risk, respiratory rate, and modified POSS (Soto & Yaldou, 2015). Patient health risk items included obstructive sleep apnea, snoring, body mass index greater than 40, same stay abdominal or thoracic surgery, anesthesia time greater than 3-hours within the last 24-hours, concomitant sedatives received within the last 2-hours, age greater than 75 years, and current smoker. Respiratory rate was assessed as a rate of 10 breaths or more per minute or less than 10 breaths per minute. The modified POSS assessed whether the patient is excessively sedated, drifts off to sleep, difficult to arouse or unarousable.

Data Collection and Management

Data were collected through chart review on patients that were administered naloxone over six months.

Data in Appendix I were collected from the EHR and placed in an Excel datasheet on the internal site drive. Next, data in the excel datasheet will be de-identified. Data were kept on a secure network password protected internal drive at the site that is accessible by members on the team from HRT.

Analysis

Data were analyzed using Statistical Analysis System (SAS) version 9.4 (statistical software) to determine if the MOSS detected opioid-induce adverse event prior to naloxone event. Factor analysis using Fisher's Exact Test will compare the proportion of risk factors that are most sensitive to scoring patient's as a risk for an opioid-related event within the MOSS, with a p-Vaule of less than 0.05 demonstrating a significant difference. A head-to-head comparison of MOSS to POSS will provide data on whether or not the difference in detection using MOSS compared to POSS is significant using McNemar's Test, with a p-Value of 0.05 demonstrating a significant difference.

Factor analysis. A factor loading of the following variables: does the patient have obstructive sleep apnea, does the patient snore, is the patient's body mass index greater than 40, did the patient have abdominal or thoracic surgery during the current hospital stay, were they under anesthesia for more than three hour or undergo anesthesia within the last 24 hours, have they received concomitant sedatives within the last 2 hours, are they older than 75 years of age, are they a smoker, is there respiratory rate 10 breaths per minute or greater, and are they excessively sedated, drifting off to sleep, or difficult/unable to arouse will be conducted (see Appendix I).

Resources & Budget

Resources for this project include the DNP student's time, the Pain Management and Opioid Prescribing Steering Committee and MOSS subcommittee, providers, pharmacists, and RNs. Further resources for this project include organizational support such as the facility itself, computers, and EHR access (see Appendix J). The DNP student is filling a need for the organization at no cost other than use of staff time to provide information or data related to the

project. The site staff involved in this project have approved time to put towards this project as part of their roles.

Timeline

See Appendix K for timeline. Institutional Review Board (IRB) approvals were obtained from the site and university (see Appendix B and C). The groundwork (i.e. performing an organizational assessment and completing a literature review) for the project was completed on November 13, 2018. Data collection concluded January 31st, 2018 and was analyzed. Data was presented to a MOSS subcommittee member on February 15, 2018. A sustainability plan was created and final defense occurred on April 17, 2019.

Results

A total of 25 naloxone cases related to adverse opioid-induced respiratory depression occurred at HRT between August 1st and December 31st, 2018. The MOSS was applied to all 25 cases retrospectively via chart audit.

Demographics

Demographics are shown in Appendix L. Mean age was 70.5 years (Standard Deviation [SD] 12.3) ranging from 34 years of age to 89 years of age. Of those audited, 77.3% (n=17) were Caucasian, 4.6% (n=1) were African American, and 18.2% (n=4) were other. Ethnicity were 12% (n=3) Hispanic and 88% (n=22) non-Hispanic. Mean length of stay was 11.9 days (SD 9.7), ranging from 1 to 35 days. The majority received naloxone in the ICU (n=13, 52%), 8% (n=2) were transferred to the ICU after naloxone administration, and 40% (n=10) remained on their current non-ICU unit. Intubation post-naloxone was required by 8% (n=2) of patients and was not required by 76% (n=19) patients.

Factors Analyzed

Patient factors analyzed in the MOSS, and thus in this quality improvement project, included presence of obstructive sleep apnea, snoring, body mass index greater than 40, same stay abdominal or thoracic surgery, anesthesia time greater than 3-hours within the last 24-hours, concomitant sedatives received within the last 2-hours, age greater than 75 years, and current smoker. Respiratory rate is assessed as a rate of 10 breaths or more per minute or less than 10 breaths per minute. The modified POSS assess whether the patient is excessively sedated, drifts off to sleep, difficult to arouse, or unarousable.

Fisher's Exact Test was used to compare the proportion of risk factors between patients that scored as safe (MOSS <2) versus unsafe (MOSS $\geq$2) using MOSS. A p-Value less than 0.05 using Fisher's Exact Test is statistically significant. Two factors, snoring (p=.0119) and abdominal and/or thoracic surgery (p=.0055), were significant results and were the most frequent risk factors to score as unsafe by the MOSS compared to all other factors (see Appendix M). As such, people who scored as at risk for an opioid-related overdose event were more likely to have the risk factors of snoring and abdominal thoracic surgery compared to any other risk factor.

Comparison of POSS to MOSS

An overall comparison of the sensitivity of the POSS to the MOSS was conducted in order to determine if combining the MOSS with the POSS would result in the increased identification of more people at risk for an opioid-related adverse event. McNemar's Test was used to compare the sensitivity of POSS versus MOSS (see Appendix N). The results from McNemar's test showed evidence (S=7.1429, p=0.0075) against the hypothesis that the two marginal totals for each risk scale are the same. Therefore, a higher proportion of patients flagged as at risk for an opioid-related event with MOSS than with POSS. Lastly, findings of the

McNemar's test indicate that 20 out of 25 (80%) patients that had an opioid-related event would have been flagged as at risk for an opioid-related adverse event rather than 8 of 25 (33.3%) with POSS alone or 18 or 25 (75%) with MOSS alone. Therefore, POSS in conjunction with MOSS flags more patients as at risk for an opioid-related adverse event than POSS or MOSS alone (see Appendix O).

Discussion

The main finding from the retrospective chart audit identified that POSS in conjunction with MOSS identified more patients as at risk for an opioid-related adverse event than a POSS or a MOSS alone. This suggests that it would be beneficial for HRT to incorporate the MOSS in the screening process in order to identify more patients at risk for an opioid-related adverse event. The POSS should continue to be utilized for in the moment assessment of patient's receiving opioids and POSS combined with MOSS should be utilized on a regular basis in order to assess patient risk factors and monitor their level of sedation.

A secondary finding identified that scoring unsafe on the risk factors of snoring and abdominal and/or thoracic surgery on the MOSS were most commonly associated with an opioid-induced adverse event. This suggests that patient's that score on these risk factors within the MOSS may need increased monitoring and equipment support, such as capnography and the use of BiPAP or CPAP.

As a result of these finding, HRT is planning to adopt the use of the MOSS into practice. As such, the MOSS Committee is meeting with stakeholders in order to finalize approval, discuss practice change, discuss equipment needs, identify strategies for staff education, and attain budget approval. Additional chart audits have been completed by staff members with the

help of the DNP student in order to gauge equipment needs. Also, changes to policy which reflect the interventions implicated by the MOSS are being discussed.

Limitations

Due to the data collection procedures reliance on accurate and timely charting by the registered nurse, there were instances of missing data present during the retrospective chart audit. Therefore, these values were unavailable for scoring within the MOSS and subsequent analysis. Missing data was excluded from final results in order to keep results as accurate as possible.

Another limitation was the small sample size. It was originally predicted that the sample size would be between 30-50 naloxone cases within HRT. However, after the original pool of cases were reviewed, cases were excluded based on location outside of HRT and circumstances that were unrelated to opioid-induced respiratory depression. After exclusions, the final number of remaining naloxone cases was 25. This number of cases was verified as an adequate sample size by the statistician for analysis of patient factors as well as sensitivity comparison between the POSS and the MOSS.

Conclusion

Pain is the most common reason people in the United States (US) seek healthcare and opioids are among the most common pharmacological class of therapeutic medications prescribed to alleviate pain across all healthcare settings (National Institutes of Health, 2018; Treede, 2018; The National Center for Health Statistics, 2017). Although opioids are standard treatment to assure patient comfort, there are many side effects, ranging from nausea and vomiting to over-sedation and respiratory depression.

According to TJC Sentinel Event database (2004-2011), 29% of the opioid-related adverse drug mortality events were related to improper monitoring of a patient, identifying a

need for organizations to increase staff awareness of factors which increase likelihood of accidental opioid over-use, over-sedation, and respiratory depression to avoid adverse patient outcomes.

Not all hospitals utilize a pre-opioid administration screening tool to assess patient risk of adverse events related to opioid administration, but rather screening tools, such as the POSS, which assess the patient's level of sedation and arousal in the moment after opioid administration has already occurred (Soto & Yaldou, 2015). Present standard respiratory assessment entails pulse oximetry combined with respiratory assessment via observation or auscultation, which has been shown to be less accurate than capnography combined with respiratory assessment (Adams, Butas, & Spurlock, 2015; Cacho, Perez-Calle, Barbado, Lledo, Ojea, & Fernandez-Rodriguez, 2010; Deitch, Miner, Chudnofsky, Dominici, & Latta, 2010; Hutchison & Rodriguez, 2008). Both practices, retrospective assessment of opioid-related adverse effects and in-the-moment respiratory assessment, are suboptimal for a patient at increased risk of opioid related respiratory depression. It is imperative that hospitals institute proactive screening tools and evidence-based monitoring to prevent opioid related adverse outcomes such as respiratory depression and death.

The purpose of this quality improvement project was to evaluate the effectiveness of the MOSS to detect opioid-induced adverse events prior to the need for naloxone in a heart center in a Midwest hospital (HRT). MOSS is an evidence-based risk assessment tool which utilizes patient characteristics as well as respiratory assessment for the prediction and early detection of opioid-induced adverse events.

The main finding from the retrospective chart audit identified that POSS in conjunction with MOSS identified more patients as at risk for an opioid-related adverse event than POSS alone, suggesting it would be beneficial for HRT to incorporate the MOSS into its screening

process in order to identify more patients at risk for an opioid-related adverse event. A secondary finding identified that scoring unsafe on the risk factors of snoring and abdominal and/or thoracic surgery on the MOSS were most commonly associated with an opioid-induced adverse event, suggesting that patients with these risk factors may need increased monitoring practices and equipment support, such as capnography and the use of BiPAP or CPAP.

As a result of these finding, HRT is planning to adopt the use of the MOSS into practice. Next steps include finalizing approval, discussing practice change, determining equipment needs, identifying and compiling education for staff, and attaining budget approval. Changes to policy which reflect the interventions identified by the MOSS also need to be addressed prior to implementation.

Implications for Practice and Further Study in the Field

Increased identification and monitoring practices for patients that are at risk for opioid-related adverse events are imperative in order to increase patient safety. Evidence demonstrates that current practices surrounding opioid monitoring strategies are suboptimal and that there is a need for a more proactive approach to decreasing adverse outcomes. This project revealed that in HRT, POSS combined with MOSS was more effective than the POSS, or the MOSS, alone in identifying patients at risk for an opioid-related adverse outcome. Future projects should include practice change strategies aimed at reducing opioid-induced adverse events after patients have been identified as at risk.

Sustainability Plan

Sustainability of this DNP project includes the following. First, pending results of the MOSS quality improvement project, providers (physicians, nurse practitioners, physician assistants, and nurses) will need to be educated on the MOSS. Next, IT will install the MOSS

into the EHR for use in addition to the POSS. Additionally, the organization will need to assess inventory numbers for equipment such as capnography and BiPAP/CPAP and purchase additional equipment if necessary. Lastly, the Pain Management and Opioid Prescribing Steering Committee and MOSS subcommittee will continue to monitor the effectiveness of the MOSS after the DNP student has completed the project.

Dissemination of Results

Results of the retrospective chart audit from the MOSS Project will be summarized and presented to both the Pain Management and Opioid Steering Committee and MOSS Subcommittee. Results will also be displayed in a poster presentation format at the Spectrum Health Research Council Poster Display on April 9th, 2019. Lastly, a formal defense presentation will take place on April 17th, 2019, in which results will be disseminated to project mentors, advisors, and all other interested and involved parties.

Reflection on DNP Essentials

The American Association of Colleges of Nursing (AACN) require that DNP students are proficient in the following 8 foundational competencies that are essential for advanced nursing practice roles. Each is reviewed.

Essential I: Scientific Underpinnings for Practice

The DNP learns to integrate nursing science with knowledge from multiple sciences, use theory to guide practice and enhance health care delivery, evaluate the outcomes, and develop new practice approaches (AACN, 2006). This essential was achieved through this project by preforming a literature search on current monitoring practices of patients that receive opioids within the hospital setting to improve patient safety. In addition, Marion Good's Theory of Balance Between Analgesia and Side Effects was used as frameworks for guiding change.

Essential II: Organizational and Systems Leadership

Leadership within organizations and systems is necessary to improve practice. This essential focuses on assessing organizations, identifying system issues, and working to facilitate changes in practice delivery to improve health outcomes and patient safety (AACN, 2006). The student demonstrated organizational and systems leadership by meeting with leaders and other stakeholders throughout the system and performing an organizational needs assessment of HRT related to naloxone events. This information was then used to determine if the MOSS in combination with the POSS would flag more patients at risk for a opioid-induced adverse event, leading staff members to increase and improve monitoring practices for these patients prior to event occurrence. Leadership and communication skills were used to assess barriers and facilitators, listen to staff and stakeholder ideas, and work with staff to encourage implementation. The student also went through the process of creating a budget for this project as well as submitting the project proposal to the organization and university HRRC committee which deemed it a non-research, quality improvement project.

Essential III: Clinical Scholarship and Analytical Methods for Evidence-Based Practice

An essential role of DNP graduates is to translate research into evidence-based practice. This involves using analytic methods to evaluate evidence, applying relevant findings for improvement of healthcare practices and outcomes, and participation in knowledge generation and collaborative research (AACN, 2006). The student used analytic methods to evaluate literature regarding the best evidence for patient respiratory monitoring practices during and after opioid administration and to analyze current naloxone event rates within the organization. The project included applying the MOSS retrospectively to individuals that experienced an opioid-related adverse event which necessitated the use of naloxone and determining if the MOSS

would have flagged the patient at risk prior to the event occurring. This quality improvement project was put in place to provide safe, patient-centered care. Information technology in the form of the EHR and Excel was used to extract, organize, and analyze data related to naloxone event occurrence and MOSS scoring.

Essential IV: Information Systems Technology

DNP graduates must be proficient in the use of, selection of, and evaluation of information systems and technology resources to support practice and improve care. This includes the related ethical, regulatory, and legal issues that come with the use of information and systems technology (AACN, 2006). For this project the student used the organization's EHR to gather data on naloxone event rates as well as patient information needed for MOSS scoring. E-mail was used for communication with stakeholders. Excel was used for organizing and analyzing data. The student was careful to follow all ethical guidelines and maintain strict confidentiality of any identifiable patient data.

Essential V: Advocacy for Health Care Policy

Heath care policy, at any level, creates a framework that can either help or impeded the ability to address health care needs by delivering high-quality health care services. Therefore, advanced practice nurses must be engaged in the process of policy development and advocacy for good health care policy. During this project the student took into account the organization's current policy and practices related to the monitoring of patients receiving opioids and the evidence regarding patient monitoring in the literature to improve current practice. This project did not include a policy change, but rather helped to create a foundation for future policy changes.

Essential VI: Interprofessional Collaboration

This essential emphasizes the importance of collaborative practice between multiple healthcare specialties in today's healthcare climate (AACN, 2006). DNP graduates must be able to work in and lead collaborative teams of professionals in order to develop and implement practice models that deliver excellent patient-centered care. For this project the DNP student met with many different professionals in the health-care system including physicians, NPs, PAs, RNs, managers, researchers, quality improvement data specialist, CNSs, and pharmacists. Communicating and working with different disciplines allowed the student to understand the current practice, evaluate needed changes, assess barriers and needed facilitators, and gain other important input in order to complete the quality improvement project.

Essential VII: Clinical Prevention and Population Health

DNP graduates have knowledge regarding clinical prevention and population health including the ability to analyze epidemiological, biostatistical, occupational, and environmental data in order to develop, implement, and evaluate care delivery models and strategies for clinical prevention and population health (AACN, 2006). This project was focused on prevention for better population health. Opioid-Induced adverse events are a population health issue which can result in morbidity and mortality, added healthcare costs, and longer hospital stays for patients. Assessing patients for risk factors for an opioid-induced adverse event prior to opioid administration allows for providers to adjust practices related to prescribing and monitoring needs of patients requiring pain medication and safely achieve the balance between analgesia and side effects.

Essential VIII: Advanced Nursing Practice

This essential specifies the primary practice competencies that are necessary in all specialties and are a foundation for DNP practice. DNP prepared nurses have the ability to:

conduct comprehensive and systematic assessments in complex situations; design, implement and evaluate interventions; develop and sustain relationships with patients and other professionals in order to provide optimal care; demonstrate systems thinking in order to improve patient outcomes; and educate and guide others through situational transitions (AACN, 2006). This project covered all of these competencies. An organizational assessment of current monitoring practice for patients receiving opioids was performed and systems thinking was used to select, implement, and evaluate the MOSS. In order to carry out this project many relationships with various stakeholders, particularly within the Pain Management and Opioid Prescribing Committee and MOSS Subcommittee, were developed and sustained. The student completed the retrospective chart audit and disseminated the results to the appropriate committees in order to collect evidence for practice change.

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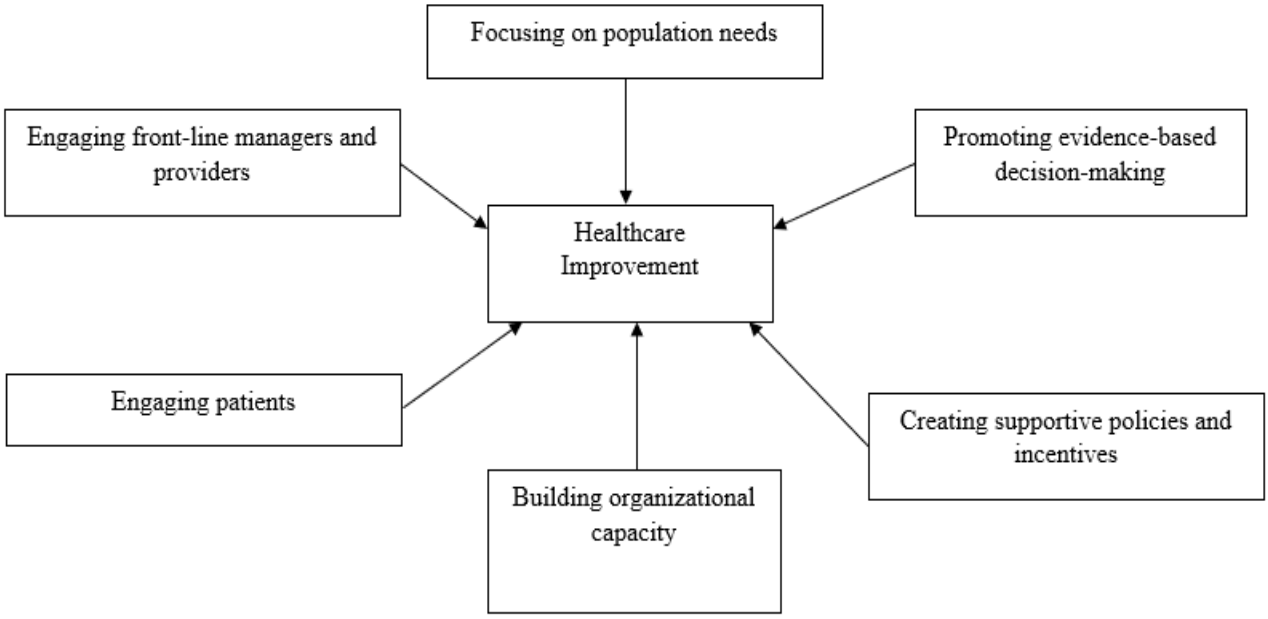
Appendices

Appendix A



Appendix A. The Canadian Foundation for Healthcare Improvement Model

Appendix B

Project Organization IRB Determination Letter

Appendix B. Available upon request.

Appendix C

GVSU IRB Determination Letter

GRAND VALLEY STATE UNIVERSITY
www.gvsu.edu

DATE:	August 23, 2018
TO:	Sandra Spoelstra
FROM:	HRRC
STUDY TITLE:	Implementing use of the MOSS (Michigan Opioid Safety Score) Tool and Interventions to reduce Opioid Related Overdose Events in High Risk Patients
REFERENCE #:	19-056-H
SUBMISSION TYPE:	HRRC Initial Submission
ACTION:	Not Research
EFFECTIVE DATE:	August 23, 2018
REVIEW TYPE:	Administrative Review

Thank you for your submission of materials for your planned scholarly activity. It has been determined that this project does not meet the definition of research* according to current federal regulations. The project, therefore, does not require further review and approval by the Human Research Review Committee (HRRC).

A summary of the reviewed project and determination is as follows:

The Joint Commission recently updated their standards, requiring hospitals to monitor all patients identified as high risk for adverse outcomes related to opioid treatment. This project will find evidence to support the use of a predictive opioid safety screening tool and implement the use of this tool in order to accomplish the goal of reducing opioid related overdose adverse events.

This project is being completed to support compliance with the accreditation standards of The Joint Commission for a local hospital, which will improve the quality of care being provided to their patients. This project is not designed to create new generalizable knowledge; therefore, IRB oversight is not required.

If the focus of this project changes to prove that the MOSS tool works for predicating opiate overdose on a larger scale, the project may then meet the federal definition of research and IRB oversight would be required at that time. If this occurs, please contact the Office of Research Integrity for information on how to proceed.

An archived record of this determination form can be found in IRBManager from the Dashboard by clicking the "_ xForms" link under the "My Documents & Forms" menu.

If you have any questions, please contact the Office of Research Compliance and Integrity at (616) 331-3197 or roi@gvsu.edu. Please include your study title and study number in all correspondence with our office.

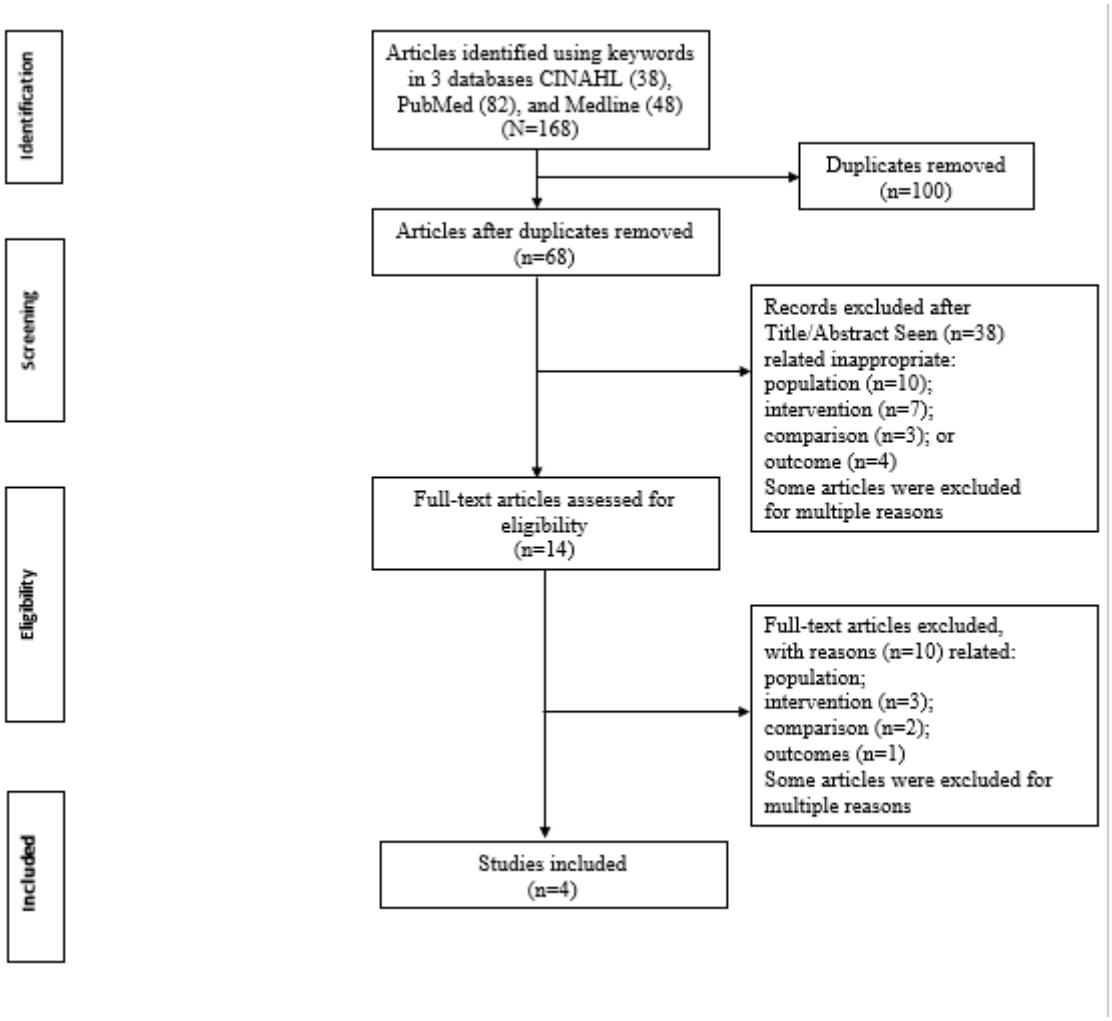
Sincerely,
Office of Research Compliance and Integrity

Appendix D

Strengths	**Weaknesses**
• Pain Management and Opioid Prescribing Committee • MOSS Sub-Committee • MOSS available within EHR • High priority due to TJC standards	• POSS based solely on patient's current level of alertness • POSS does not consider patient risk factors
Opportunities	**Threats**
• Forefront of impactful changes related to the opioid crisis • Increase education of staff regarding patient risk factors	• Loss of accreditation and Magnet status • Financial loss and damaged reputation

Appendix D. SWOT Analysis of the MOSS

Appendix E



Appendix E. PRISMA Flow diagram of search selection process

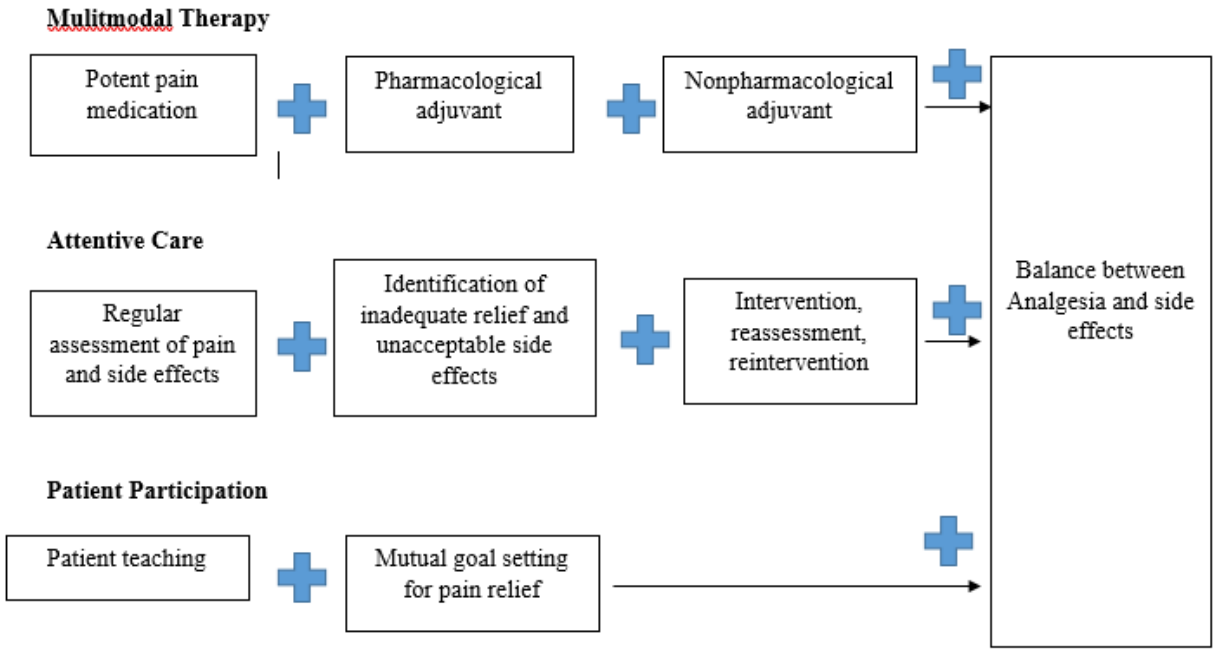
Appendix F

Author (Year) purpose	Design (N)	Inclusion criteria	Intervention vs. comparison	Results	Conclusion
Adams (2015) evaluate usefulness of capnography versus pulse oximetry	Prospective, single-group, observational design (N=200)	>18 years old, able to read and speak English, and who were alert, oriented, and able to provide consent and adult patients undergoing TEE	Staff-blinded capnography vs standard assessment with pulse oximetry	Respiratory depression developed in 45% (n=90). Of 90, SPO2 at the time of respiratory depression was M=96.8% (range 87% to 100%). At the time that respiratory depression was 5 (5.5%) an SPO2 of ≤91%.	Capnography detected respiratory depression before pulse oximetry
Cacho et al. (2010) compare standard pulse oximetry with capnography for the monitoring of ventilatory status during colonoscopies under sedation	Prospective study (N=50)	>18 years old, non-ventilated, and no allergies to sedation and/or analgesia medications	Capnography vs pulse oximetry	Capnography detected 29 episodes of anomalous ventilation in n=16, mean 54.4 seconds. Pulse oximetry detected oxygen desaturation in 38% of episodes. Two episodes of disturbed ventilation were simultaneously detected by capnography and pulse oximetry.	Respiratory disorders during colonoscopies are detected to a greater extent and earlier by capnography compared to conventional pulse oximetry.
Deitch et al. (2010) determine whether physician use of	Randomized controlled trial (N=132)	>18 years old and selected for propofol sedation; no history of	Study group (standard monitoring and capnography)	Seventeen patients in the nonblinded group and 27 patients in the	Physicians performing ED procedural sedation with propofol decreased the rate of

real-time capnography was associated with 15% decrease in the incidence of hypoxia compared with standard monitoring alone		COPD, chronic oxygen requirements, or respiratory distress and during ED procedural sedation with propofol	vs control group (standard monitoring and blinded capnography)	blinded group experienced an SpO2 level of less than or equal to 93%. With capnography there were more physician interventions to improve respiratory status, 24 of 68 (22%).	hypoxic events by using capnography in conjunction with standard monitoring (17%, p=.035) and clinically significant.
Hutchison & Rodriguez. (2008) determine whether capnography alone was more sensitive than pulse oximetry with respiratory rate assessment by observation or auscultation to detect respiratory depression	Randomized, controlled trial (N=54)	Physician's order for opioid analgesia and be older than 18 years of age, has to be breathing spontaneously (nonventilated), be without a diagnosis of OSA, not be using a CPAP device, and be able to report a pain intensity on a 0-10 pain rating scale	Study group (capnography alone) vs control group (monitored every four hours by spot check pulse oximetry and respiratory rate assessment by observation or auscultation)	Respiratory depression was detected at a significantly higher rate in the capnography group (P=0.03). In total, 146 episodes of respiratory depression were detected during the 36 hours: 140 in the capnography group and 6 in control group; n=17 (15 in the capnography group and two in the control group) accounted for all episodes of respiratory depression.	Capnography was more effective in detecting "subclinical" respiratory depression than pulse oximetry during procedural sedation.

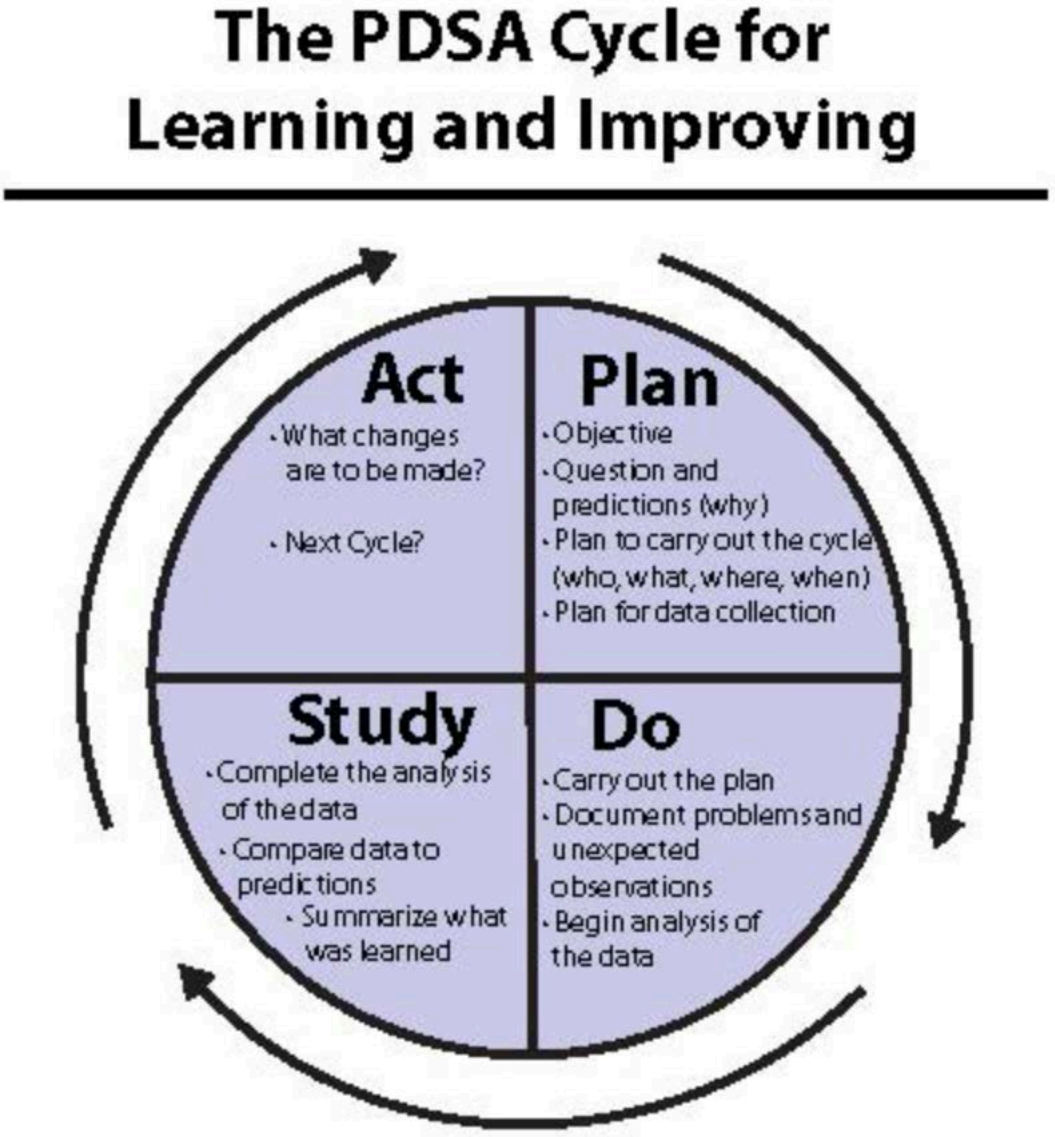
Appendix F. Articles included in review with author, year, purpose, design, inclusion, results, conclusions

Appendix G



Appendix G. Marion Good's (1998) Theory of Balance Between Analgesia and Side Effects

Appendix H



Appendix H. Institute for Healthcare Improvement's Plan Do Study Act Implementation Model (IHI, 2017). Retrieved from http://www.ihi.org/resources/Pages/Tools/PlanDoStudyActWorksheet.aspx

Appendix I

	Item	Measurement Level	Findings
Patient ID	MRN/FIN	Numeric	
Patient Demographics	DOB	Numeric	
	Race	1=Caucasian 2=African American 3=Other	
	Ethnicity	1=Non-Hispanic 2=Hispanic	
Medication Administration	Date of naloxone administration	Numeric	
Health Risk			
Group 1	Does the patient have OSA?	0=No 1=Yes (Categorical)	
	Does the patient snore?	0=No 1=Yes (Categorical)	
	Does the patient have a BMI >40	0=No 1=Yes (Categorical)	
Group 2	Did the patient undergo abdominal or thoracic surgery during this admission?	0=No 1=Yes (Categorical)	
	Was the patient under anesthesia for > 3 hours within the last 24 hours?	0=No 1=Yes (Categorical)	
Group 3	Did the patient receive concomitant sedatives within the last 2 hours?	0=No 1=Yes (Categorical)	
Group 4	Is the patient older than 75 years of age?	0=No 1=Yes (Categorical)	
	Is the patient a current smoker?	0=No 1=Yes (Categorical)	
Respiratory Rate	Is the patient's respiratory rate less than 10 breaths per minute?	0=No 1=Yes (Categorical)	
Modified POSS	Is the patient excessively sedated, drifting off to sleep, difficult to arouse or unable to arouse?	0=No 1=Yes (Categorical)	
Patient MOSS		Numeric	

Appendix I. Table of Measures.

Appendix J

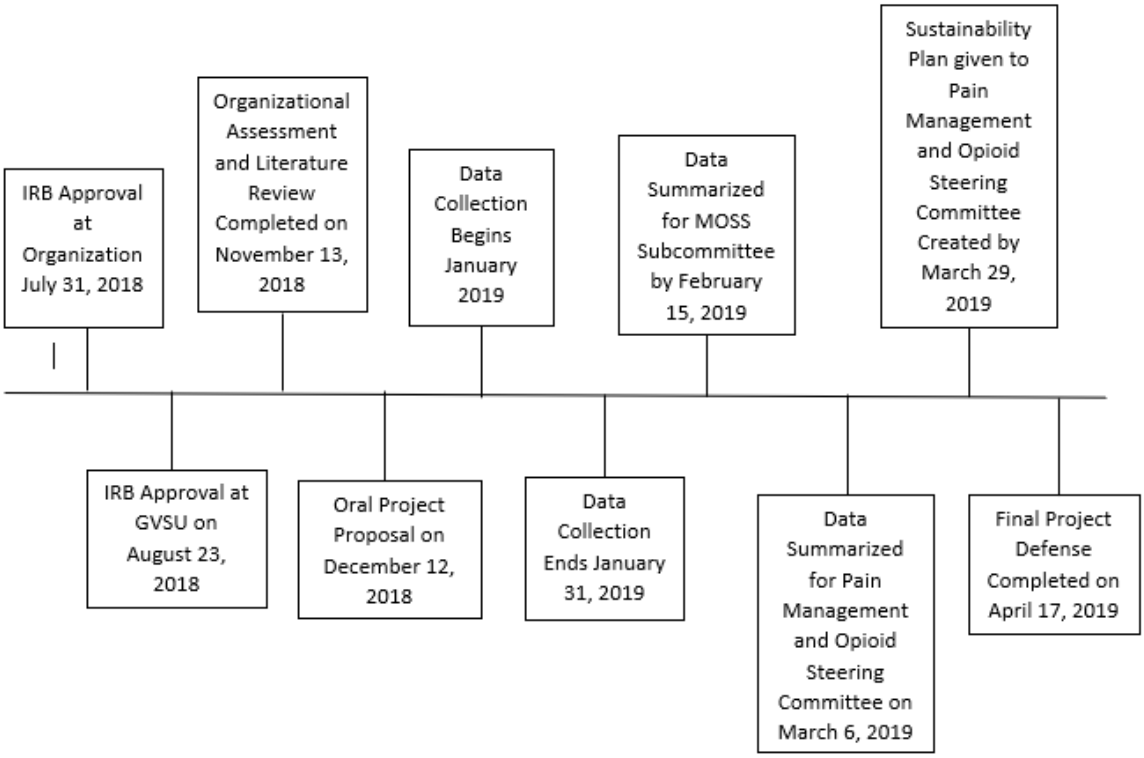
Budget

Doctor of Nursing Practice Project Financial Operating Plan	
Implementing use of the MOSS (Michigan Opioid Safety Score) Tool and Interventions to reduce Opioid-Related Overdose Events in High Risk Patients at a Heart Center in a Midwest Hospital	
Revenue	
Project Manager Time (in-kind donation)	6,200.00
Consultations	
Statistician (in-kind donation)	100.00
Cost mitigation	
Prevention of 1 case of opioid-induced respiratory depression-related Intensive Care Unit stay with ventilator care for 8 days / per year	12,176.00*
TOTAL INCOME	18,476.00
Expenses	
Project Manager Time (in-kind donation)	6,200.00
Team Member Time:	
Clinical Nurse Specialist (1)	2,000.00
Consultations	
Statistician (in-kind donation)	100.00
TOTAL EXPENSES	8,300.00
Net Operating Plan	10,176.00

* Overdyk, F. J., Dowling, O., Marino, J., Qiu, J., Chien, H. L., Erslon, M., Morrison, N., Harrison, B., Dahan, A., … Gan, T. J. (2016). Association of opioids and sedatives with increased risk of in-hospital cardiopulmonary arrest from an administrative database. *PloS one*, *11*, 1-13.

Appendix K

Project Timeline



Appendix L

Demographics

Characteristic	Mean (SD) Range N=25
Age	70.5 years (12.3) 34.4-89.3 years
LOS	11.9 days (9.7) 1-35 days
	% (n)
Race	
Caucasian	77.3% (17 of 25)
Other	18.2% (4 of 25)
African American	4.6% (1 of 25)
Ethnicity	
Non-Hispanic	88% (22 of 25)
Hispanic	12% (3 of 25)
Transfer to ICU	
Already There	52% (13 of 25)
No	40% (10 of 25)
Yes	8% (2 of 25)
Intubated	
No	76% (19 of 25)
Already Intubated	16% (4 of 25)
Yes	8% (2 of 25)

Appendix L. Age, hospital length of stay, Race, Ethnicity, transfer to ICU or intubated after administration of Naloxone.

Appendix M

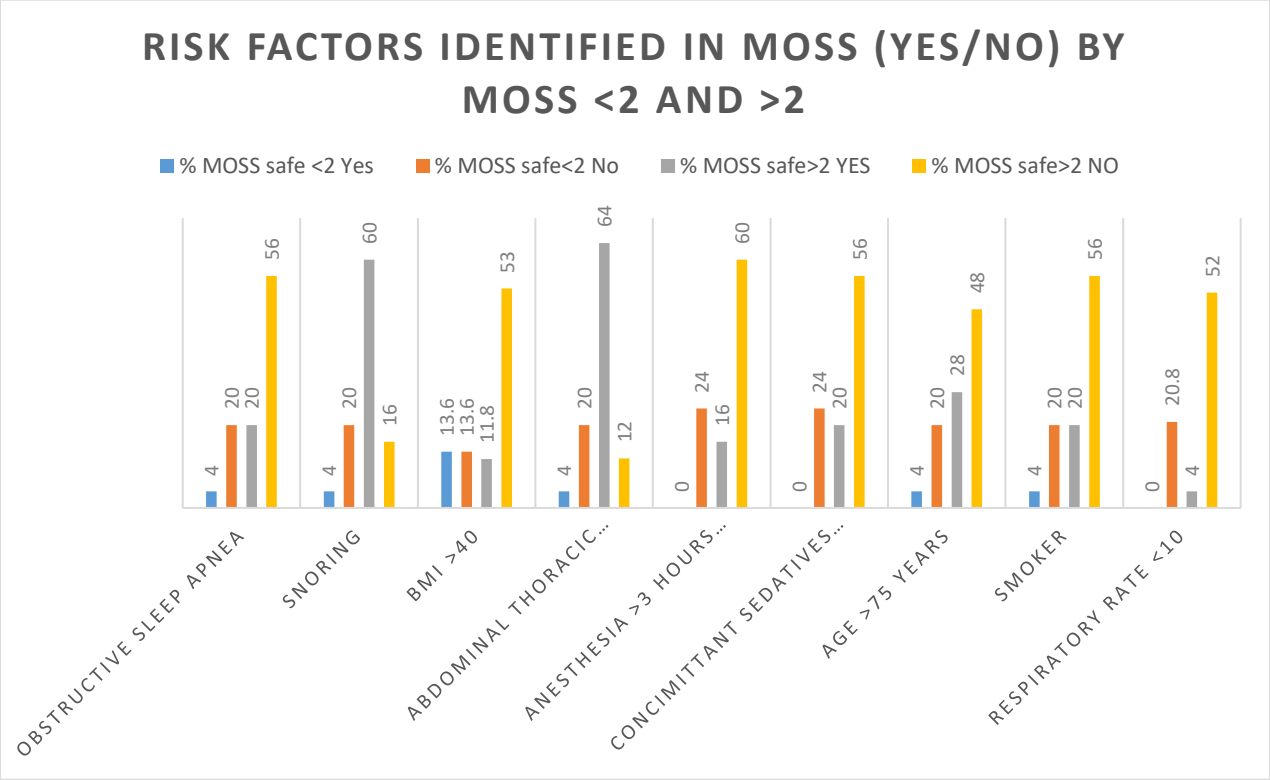
Table Frequencies of Risk Factors

	MOSS Scored as safe % (n)		
	(<2)	(≥2)	p-Value
Obstructive sleep apnea	4% (1 of 25) Yes 20% (5 of 25) No	20% (5 of 25) Yes 56% (14 of 25) No	1.000
Snoring	4% (1 of 25) Yes 20% (5 of 25) No	60% (15 of 25) Yes 16% (4 of 25) No	0.0119*
BMI > 40	13.6% (3 of 22) No 3 of 25 missing data	11.8% (2 of 17) Yes 53% (9 of 17) No 8 of 25 missing data	1.000
Abdominal/Thoracic Surgery	4% (1 of 25) Yes 20% (5 of 25) No	64% (16 of 25) Yes 12% (3 of 25) No	0.0055*
Anesthesia > 3 hours within 24 hours	24% (6 of 25) No	16% (4 of 25) Yes 60% (15 of 25) No	0.5404
Concomitant sedatives within 2 hours	24% (6 of 25) No	20% (5 of 25) Yes 56% (14 of 25) No	0.2887
Age > 75 years	4% (1 of 25) Yes 20% (5 0f 25) No	28% (7 of 25) Yes 48% (12 of 25) No	0.6237
Current smoker	4% (1 of 25) Yes 20% (5 of 25) No	20% (5 of 25) Yes 56% (14 of 25) No	1.000
Respiratory rate <10	20.8% (5 of 24) No 1 of 25 missing data	4% (1 of 25) Yes 52% (13 of 25) No	1.000

Appendix M. Obstructive sleep apnea, snoring, body mass index greater than 40, same stay abdominal or thoracic surgery, anesthesia time greater than 3 hours within the last 24 hours, concomitant sedatives with 2 hours, age greater than 75 years old, current smoker, and respiratory rate less than 10 breaths per minute.

Appendix N

Figure Frequencies of Risk Factors



Appendix N. Obstructive sleep apnea, snoring, body mass index greater than 40, same stay abdominal or thoracic surgery, anesthesia time greater than 3 hours within the last 24 hours, concomitant sedatives with 2 hours, age greater than 75 years old, current smoker, and respiratory rate less than 10 breaths per minute.

Appendix O

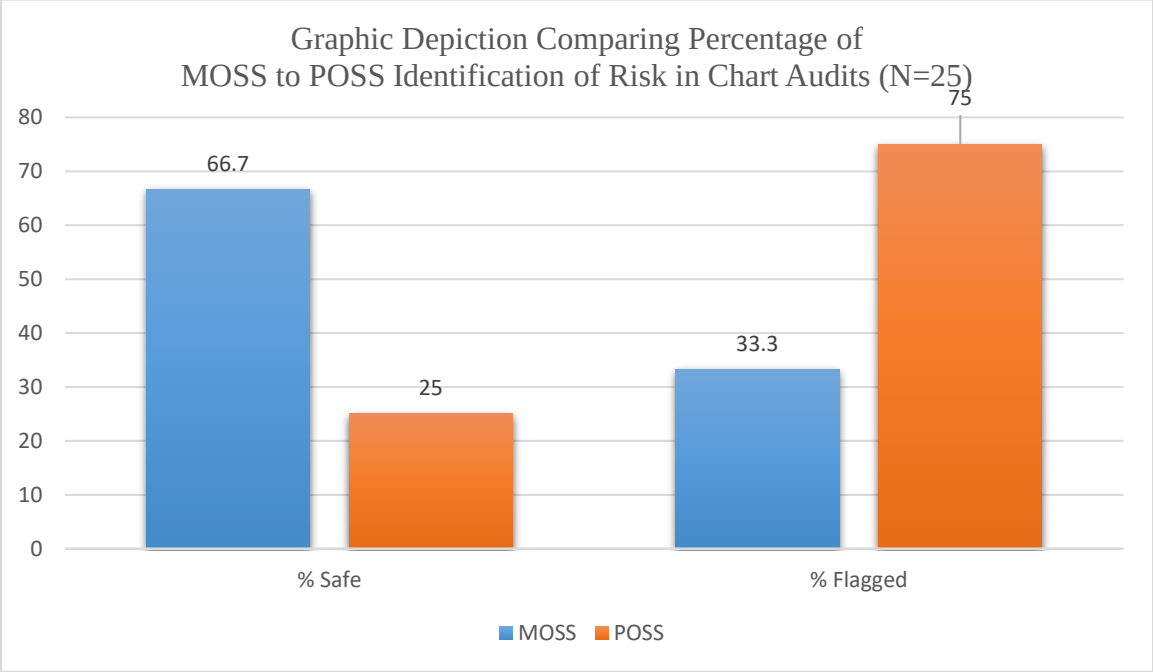
Table Comparing MOSS to POSS Identification of Risk

POSS	MOSS	p-Value
66.7% (16 of 25) Safe 33.3% (8 of 25) Flagged	25.0% (6 of 25) Safe 75.0% (18 of 25) Flagged	0.0075

Appendix O. POSS scoring as safe (<2) and POSS scoring unsafe (≥2) compared to MOSS scoring as safe (<2) and MOSS scoring unsafe (≥2) within same patient population (n=25).

Appendix P

Figure Comparing MOSS to POSS Identification of Risk



Appendix P. POSS scoring as safe (<2) and POSS scoring unsafe (≥2) compared to MOSS scoring as safe (<2) and MOSS scoring unsafe (≥2) within same patient population (n=25).