Improving Pain Assessment in Mechanically Ventilated Adults Requiring Ground Transport

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Abstract

Problem: Accurate pain assessment is necessary for adequate pain management, yet zero of the 93 mechanically ventilated adults requiring ground transport were assessed using a validated pain tool between January and October 2023. Recognizing this gap, departmental leadership prioritized improving pain assessment, which is supported by current literature. ***Purpose:*** This QI project aimed to standardize pain assessment among mechanically ventilated adults requiring ground transport by integrating the Critical-care Pain Observation Tool (CPOT), a validated pain assessment tool, into the pain and sedation management protocol. ***Methods:*** After thorough literature review, approval for CPOT integration was obtained from the program's medical director and departmental leadership. The updated protocol was distributed to staff, and the electronic health record was modified to include the CPOT for documentation. Education was provided to staff regarding the usage and documentation of the CPOT, which was tracked via a REDCap survey. Weekly audits were performed to monitor adherence to the updated policy, and results were tracked in a separate REDCap survey. ***Results****:* Staff education reached 81% by the end of the second week. Staff expressed the ease of usability and documentation of the tool, and the applicability to practice the tool has for the target population in their REDCap survey responses. During the 15-week implementation period, over 95% of mechanically ventilated adults requiring ground transport were assessed using the updated protocol (n=42/44). ***Conclusions:*** Incorporating a validated pain assessment tool into the pain and sedation management protocol for patients with an advanced airway was an effective strategy to improve pain assessment in this vulnerable population.

Keywords: pain assessment, pain management, mechanical ventilation, critical care transport, ground transport, adult, critical-care pain observation tool, CPOT

Improving Pain Assessment in Mechanically Ventilated Adults Requiring Ground Transport

An accurate and timely pain assessment is crucial for the treatment and prevention of complications related to uncontrolled pain (Devlin et al., 2018). Mechanically ventilated patients pose unique challenges to adequate pain assessment due to their inability to communicate pain via the standard numeric verbal pain scale. The American Association of Critical-Care Nurses (AACN) and the Society for Critical Care Medicine (SCCM) recommend using a validated pain assessment tool to adequately assess pain in mechanically ventilated patients who are unable to provide a verbal pain score (AACN, 2018; Devlin et al., 2018).

The clinical site was a critical care transport program at a large academic medical center. The program transports critically ill patients, many of whom require mechanical ventilation, and utilizes a series of protocols to allow clinicians to provide timely intervention to critical patients. Between January 2023 and October of 2023, zero of the 93 mechanically ventilated adults requiring ground transport were assessed using a validated tool. Prior to the quality improvement (QI) project implementation, the pain and sedation protocol for patients with an advanced airway utilized the verbal pain scale, which is not validated in this patient population. Due to the discrepancy, pain interventions were administered based on assessments using a non-validated tool. See Figure 1 for the root cause analysis. Left unaddressed, uncontrolled pain can lead to reduced quality of life, decreased productivity, unnecessary suffering, and the development of chronic pain (Daoust et al., 2020). The purpose of this QI project was to standardize pain assessment among mechanically ventilated adults requiring ground transport by incorporating a validated pain assessment tool into the pain and sedation protocol for patients with an advanced airway.

Available Knowledge & Specific Aims

A literature review was performed to identify evidence-based solutions to improving pain assessment for mechanically ventilated adults. The search was guided by the purpose statement to formulate a purpose, intervention, context, outcomes, and time (PICOT) question: "Among mechanically ventilated adults requiring transport, how does implementing a validated pain assessment tool into the pain and sedation management protocol, compared to pain assessment using a non-validated pain tool, impact pain assessment?"

The literature review was conducted using EBSCOhost. The terms "pain assessment, pain evaluation, OR pain management," and "mechanical ventilation OR mechanically ventilated" were extrapolated from the PICOT question. The initial search yielded 1,482 articles which were then narrowed by exclusion criteria (article age, peer reviewed status, English language, and adult population). The remaining 156 articles were reviewed by their abstract, 117 were excluded based on exclusion criteria. The final 39 articles were reviewed using the full text, resulting in seven articles included in the evidence review. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) can be found in Figure 2.

Of the seven articles reviewed, two were level one randomized controlled trials, three were level two quasi-experimental studies, and two were descriptive observational studies. All were good or high quality based on the Johns Hopkins Nursing Evidence-Based Practice rating scale (Newhouse et al., 2005). The evidence appraisal and synthesis tables can be reviewed in Table 1 and Table 2, respectively.

According to two of the studies, pain management protocols that incorporated a validated pain tool intended for use in mechanically ventilated adults were an effective strategy to reduce pain scores and overall opioid use (Besen et al., 2019; Dehghani et al., 2019). Isenberg et al.

(2018) found that the incorporating changes to the electronic health record (EHR) also increased adherence to the SCCM's clinical practice guideline recommendations and improved overall patient outcomes. There were multiple validated pain tools to assess pain in mechanically ventilated adults identified in the literature review, such as the behavioral pain score (BPS) and the Critical-care Pain Observation Tool (CPOT) (Emsden et al., 2018; Gelinas et al., 2006; Rijkenberg et al., 2017). However, Kouhi et al. (2023) found the CPOT, compared to the BPS, resulted in lower pain scores without oversedation. The CPOT is widely available for use, has been adapted into many languages, and validated in a variety of settings. Based on these findings, the CPOT was chosen for integration into the pain and sedation management protocol for patients with an advanced airway, as well as modification to the EHR for documentation, to improve pain assessment in mechanically ventilated adults requiring ground transport.

Rationale

The Promoting Action on Research Implementation in Health Services (PARIHS) QI framework was chosen to guide implementation. As shown in Figure 3, three major factors contribute to successful implementation of QI initiatives: evidence, facilitation, and context. Figure 4 further illustrates the critical role of a strong context in insuring successful implementation. This framework was chosen specifically because it emphasizes the importance of context for achieving success. Kitson et al. (2008) suggest that successful implementation is heavily influenced by strong context and the facilitation of leadership compared to strong evidence alone. The clinical department in which the project was implemented has highly trained and skilled staff who were amenable to the change. These concepts were leveraged though the willingness of leadership and staff to change the current protocol to improve patient outcomes.

See Figure 5 for the process map prior to implementation and Figure 6 for the desired process map.

The local context's utilization of clearly defined protocols was the basis for the intervention, with the assumption that staff would use a validated pain assessment tool intended for use in the target population if it were integrated into the pain and sedation management protocol for patients with an advanced airway. Staff are trained to utilize protocols to guide treatment and interventions, such as the administration of analgesics for pain control. Adherence to protocols is monitored through the pre-established quality assurance process, where charts are audited for compliance and feedback is provided to clinicians for any protocol deviation. Incorporating the CPOT into the protocol allowed staff to refer to a validated assessment tool when deciding appropriate interventions based on the clinical condition. Staff were encouraged to obtain a medical consult with medical direction if there were concerns about administering analgesia, or if pain was uncontrolled despite administration.

Methods

Context

The local context was assessed using the Context Assessment Index (CAI), a validated tool for assessing healthcare context based on the PARIHS framework (McCormack et al., 2009). The CAI is a series of 37 questions aimed at understanding the context, culture, and leadership of a healthcare department as it relates to implementing evidence-based changes (see figure 7). This tool was chosen due to the emphasis of context on successful QI implementation.

The local context scored 71.4% for culture, 74.97% for leadership, and 72.98% for evaluation, resulting in an average score of 73.17% for the context. This score suggested that the local context was receptive to change but may have inconsistency in providing feedback to

individuals on their performance. Based on this evidence, QI efforts were supported by direct feedback to clinicians to encourage continued participation through the pre-established quality assurance procedures, as well as efforts to display QI project progress in the form of a run chart displayed throughout the department and updated on a bi-weekly basis. Staff members were engaged in the suggested practice change during informal conversations and recruitment of change agents prior to implementation, which likely bolstered the context for change.

Intervention

Working with departmental leadership, the medical director, and local change agents, the CPOT was added to the existing protocol, see Appendix A. As this QI project aimed to improve pain assessment among mechanically ventilated adults, the CPOT was modified to exclude scoring for verbal patients to ensure clarity and ease of use for staff. Refer to Appendix B for the revised CPOT. Once approved by the medical director and departmental leadership, the protocol was distributed to all staff in both print and digital format in the two weeks following the go-live on August 26, 2024. A roster of all current employees was used to ensure that all staff received a printed copy, and the department's email listserv was used to distribute digital copies.

During the first two weeks of the implementation, 81% of staff attested to receiving simulation-based education on the CPOT usage and documentation. The departmental educational model utilizes shift drills to introduce staff to evidence-based practices in a simulated environment. Shift drills are held regularly, and staff are required to attend. Education was presented during a dedicated shift drill which was developed by the project lead and received approval from the clinical site representative, medical director, and nursing manager. Staff were asked to complete a REDCap survey attesting to their participation in education, which also provided an opportunity for feedback (see Appendix C).

Measures

Prior to implementation, specific goals and measurement strategies were established for the structure, process, and outcome goals. The structure goal was the CPOT would be integrated into the pain and sedation management protocol for patients with an advanced airway within one week of QI project implementation. The process goal was 100% of staff would be trained on the use and documentation of the CPOT within two weeks of the QI project's go-live date of August 26, 2024. Finally, the outcome goal was 100% of mechanically ventilated adults requiring ground transport would be assessed using the CPOT at the beginning and end of transport within four weeks of QI project implementation.

The structure goal was measured by the integration of the CPOT into the protocol and the EHR. The process goal was measured through the participation of staff in simulation-based education and their completion of the REDCap survey. Staff survey responses were compared to an active roster of employees to determine the percentage of staff who completed education. The outcome goal was measured through weekly chart audits utilizing the EHR's analytics tools, wherein a report was generated based on the presence of an advanced airway, mechanical ventilation, or both to ensure that all eligible patients were identified. Using this report, the project lead reviewed eligible charts for CPOT documentation, and results were recorded in a REDCap survey (see Appendix D). The project lead was authorized to generate this report in the EHR by department leadership. The report was generated every Sunday to encompass the previous week (Sunday – Saturday cycle). The number of eligible patients assessed using CPOT were compared to the total number of eligible patients transported to determine the percentage of compliance with the updated protocol. Table 3 provides details on the SMART goals and specific measurement strategies. The project timeline GANTT chart can be found in Appendix E.

Analysis

Staff comments entered into the REDCap survey were informally analyzed. The comments were used to identify early adopters and other potential change agents, as well as staff that were more resistant to the change. These comments also provided staff an opportunity for bi-directional feedback during implementation.

Weekly chart audits were performed every Sunday by the project lead utilizing the EHR's audit tools. These tools allow clinicians to generate a report filtering patient charts based on specific variables, such as the presence of mechanical ventilation or an advanced airway. With the help of the clinical site representative, the project lead was authorized to generate the report using mechanical ventilation OR advanced airway and pain assessment type AND pain score. These data points were analyzed weekly using descriptive statistics, and the mean was entered into a Run Chart.

Ethical Considerations

Non-human subject's research determination from the Human Research Protections Office of the University of Maryland's School of Nursing Institutional Review Board (IRB) was obtained prior to QI project implementation. The facility's IRB approval process was followed per the appropriate policy (see Appendix F).

The use of the EHR's analytics tools was utilized to identify all eligible patients. The project lead generated the report on a secure network within a private, on-site location at the clinical facility. Data was extracted from the deidentified report, with compilation into REDcap which was then translated into a Run Chart. No patient identifiers were relayed into either REDcap or the Run Chart. REDCap utilizes a password-protected server with dual identification to ensure HIPAA compliance and patient confidentiality. For additional patient privacy

protection, the project lead completed five online training modules on data security, privacy protection, and health insurance portability and accountability act (HIPAA) regulations (see Appendices G through K).

The project lead was employed within the department where the QI project was implemented, presenting a potential conflict of interest. However, the project lead did not have any managerial responsibilities within the institution.

Results

The first step in the QI implementation process was achieving the structure goal of incorporating the CPOT into the protocol and EHR, which required approval from the medical director and departmental leadership. The updated protocol was drafted and approved for implementation prior to the beginning of implementation, enhancing the success of this structure goal. The department's information technology specialist was engaged to modify the EHR for documentation.

The process measure aimed to educate 100% of staff on the updated protocol by the end of the second week. This was measured using staff-completed REDCap surveys during educational sessions and results were then compared to an active roster of staff. Only 81% of staff completed the survey attesting to receiving simulation-based education by the end of the second week. All staff received an email from the medical director outlining changes in the updated protocol with the protocol as an attachment.

The outcome goal was measured by the percentage of mechanically ventilated adults requiring ground transport who were assessed using CPOT, compared to the total number of mechanically ventilated transports, and was reported as adherence to the updated protocol. During the first week, 66% of eligible patients were assessed using the CPOT per the updated

protocol. Adherence quickly rose to 100% and sustained at goal until week ten. During week ten adherence decreased to 80% but returned to 100% during week 11 where it remained. There were no eligible transports during weeks seven and 14. The percentages of adherence were translated into a Run Chart for data trending. The Run Chart with annotations regarding implementation initiatives can be found in Appendix L. The Run Chart was updated on a bi-weekly basis and displayed throughout the department to encourage continued participation, in line with the results from the CAI.

During the 15-week implementation period there were 44 mechanically ventilated adults transported via ground. Of the 44 patients, 42 were assessed using the CPOT at the beginning and end of the transport, per the updated protocol, resulting in a 95% adherence rate throughout the implementation period. The lowest weeks for adherence were during weeks one and ten. Staff comments on the REDCap survey voiced support of the change, noting the tools ease of use and clinical relevancy. There were no unintended consequences identified.

Discussion

This QI project aimed to standardize pain assessment among mechanically ventilated adults requiring ground transport through the integration of a validated pain assessment tool into the pain and sedation management protocol for patients with an advanced airway. The findings of the QI project were consistent with the literature, in that implementing a validated pain assessment tool improved pain assessment in mechanically ventilated adults. However, none of the identified studies focused specifically on pain assessment in transport. There is limited evidence in critical care transport overall, decreasing the generalizability of this QI project.

The process goal was to reach 100% of staff for education by the end of the second week. Only 81% of staff completed the REDCap survey attesting to receiving education, likely related

to the work schedules and physical locations staff are assigned. Despite this, adherence remained strong. Simulation-based education provided staff an opportunity to utilize the tool in a realistic scenario, which increased familiarity with the tool and the documentation of findings. Staff comments from completed REDCap surveys obtained during simulation-based training remarked at the tools ease of use and clinical relevancy. These factors likely aided in early adaptation. The context assessment helped to identify strategies to promote adherence to the protocol, such as the display of the updated Run Chart in the department. The Run Chart was prominently displayed on an educational board in the team room, where staff often gather for meals and discussions.

During week ten there was a decrease in adherence, likely related to the increase in patient volume. Key stakeholders, such as departmental leadership and local change agents, were re-engaged through informal discussions. Adherence quickly returned to 100% for the remainder of the implementation period. The department's culture of continuous improvement was pivotal to the success of the QI project.

Modifying the existing policy required minimal time and effort from leadership, as all departmental policies are reviewed and updated on an annual basis at baseline, facilitating adoption of the protocol. Many of the staff participate in annual protocol revisions, providing an opportunity for engagement and feedback about protocol changes. Change agents were recruited to answer questions about the updated protocol or the utilization of the tool and were fundamental to the success of the QI project. The utilization of the PARIHS frameworks emphasis on local context was a strength of the project.

Prior to implementation, a MOCHA sustainability plan was developed in collaboration with the clinical site representative and school faculty to ensure lasting sustainability of the QI initiative, see Appendix M. The MOCHA sustainability plan was developed using the Institute

for Healthcare Improvement's sustainability planning worksheet (2019). Measurement of adherence to the protocol will continue through the department's robust quality assurance processes. New employees will receive training on the tool during orientation. The CPOT will indefinitely remain a part of the pain and sedation management protocol for patients with an advanced airway.

Conclusion

Adequate pain assessment and management are imperative to prevent unnecessary suffering. This QI project provided staff with a validated pain assessment tool intended for use in a vulnerable population, enhancing the clinicians' ability to assess and manage pain in mechanically ventilated adults requiring ground transport. Current literature clearly aligns with standardized pain assessments using validated pain assessment tools, such as the CPOT, to assess pain in mechanically ventilated adults. Adherence to the updated protocol was strong throughout the implementation period; the CPOT will remain part of the protocol. There is limited literature focused on critical care transport. Future QI initiatives should include the evaluation of this project's impact on the utilization of analgesics in the critical care transport environment. Additionally, more research is needed to determine how to translate current best practices for typical critical care settings into the critical care transport environment.

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Table 1

Evidence Appraisal Table: Improving Pain Assessment in Mechanically Ventilated Adults Requiring Ground Transport

1. Ayasrah, S. M. (2019). Pain among non-verbal critically ill mechanically ventilated patients: Prevalence, correlates and predictors. *Journal of Critical Care, 49*, 14-20. https://doi.org/10.1016/j.jcrc.2018.10.002

Level: II

Purpose or Hypothesis	Type of Evidence and Research Design	Sample (population, size, setting)	Intervention Procedures	Primary Outcome/Measures	Results Conclusions
To investigate factors that are predictive of pain and pain levels for mechanically ventilated patients during periods of rest and routine nursing procedures	Cross-sectional, quasi-experimental, prospective, descriptive, correlational design	Convenience sampling of mechanically ventilated adult patients in medical/surgical ICUs in Amman, Jordan. Minimum sample size was calculated to be 184, a total of 247 patients were recruited	BPS and a sedation scale were documented pre- and post- routine nursing procedures such as repositioning, oral care, and venipunctures. Scores were reported by specially trained research nursing staff	BPS scores pre- and post- routine nursing procedures and the administration of analgesic or sedative medications one hour	Patients experience pain at rest and during routine care. Pain at rest may be predicted by patient's age and ventilation via tracheostomy. Younger patients were more likely to have higher pain post-routine care procedures. Patients who received analgesia within 1 hour of routine care procedures had lower pain scores

2. Besen, B. A. M. P., Junior, A. P. N., Lacerda, F. H., Dias de Silva, C. M., Tota de Souza, V., Martins, E. V. N., Lopez, A. T. A., Brandao, C. E., & Fernandes de Oliveira, F. (2019). Pain management protocol implementation and opioid consumption in critical care: an interrupted time series analysis. *Revista Brasileira de Terapia Intensiva, 31*(4), 447-455. https://doi.org/10.5935/0103-507X.20190085

Level: II

Purpose or Hypothesis	Type of Evidence and Research Design	Sample (population, size, setting)	Intervention Procedures	Primary Outcome/Measures	Results Conclusions
Implementation of a pain management protocol and to assess the overall impact on fentanyl consumption	Quasi-experimental, retrospective, pre-/post- cohort study	Convenience sampling of all adult patients admitted to a mixed medical/surgical 20-bed ICU during a specific period. As study design was retrospective, no formal sample size was calculated. 2826 total patients enrolled	Pre-intervention: high-concentration fentanyl infusion for analgesia Post-intervention: structured pain management protocol based on BPS scores	Consumption of analgesics before and after the implementation of a standardized pain management protocol	Reduction in opioid use post-intervention

3. Dehghani, Z., Keikhaei, A., Yaghoubinia, F., Keykha, A., & Khoshfetrat, M. (2019). Impact of pain management algorithm on pain intensity of patients with loss of consciousness hospitalized in intensive care unit: a clinical trial. *Medical-Surgical Nursing Journal, 7*(4), 1-7. https://doi.org/10.5812/msnj.90274

Level: I

Purpose or Hypothesis	Type of Evidence and Research Design	Sample (population, size, setting)	Intervention Procedures	Primary Outcome/Measures	Results Conclusions
Evaluate the impact of implementing a pain management algorithm on the level of pain in patients with a loss of consciousness admitted to an ICU	Randomized clinical trial	Convenience sampling of adult intubated patients with loss of consciousness admitted to the ICU of Khatam al-Anbiya Hospital in Zahedan, Iran. Sample size was estimated at 42, and a total of 90 patients were studied.	Pain was assessed using BPS by a trained clinician. If pain was between 3 and 5, pain relief measures would be reduced after consultation with the primary provider. If the BPS exceeded 5, pain relief measures would be increased after consulting with the primary provider.	Pain scores as measured by BPS and the frequency/dose of analgesics	Pain management algorithms decreased the incidence of pain observed in patients suffering loss of consciousness

4. Emsden, C., Schafer, U. B., Denhaerynck, K., Grossman, F., Frei, I. A., & Kirsch, M. (2018). Validating a pain assessment tool in heterogenous ICU patients: Is it possible? *Nursing in Critical Care, 25*(1), 8-15. https://doi.org/10.1111/nicc.12469

Level: III

Purpose or Hypothesis	Type of Evidence and Research Design	Sample (population, size, setting)	Intervention Procedures	Primary Outcome/Measures	Results Conclusions
Validation of the German CPOT and to determine the feasibility of use in clinical practice	Observational study applying a repeated measures design	Setting: 24-bed ICU at a hospital in Basal, Switzerland Sample: 60 mechanically ventilated adult medical-surgical patients resulting in 120 pain observations	Questionnaire distributed to RNs to determine the feasibility of use of the German CPOT scale Validity was assessed utilizing interrater reliability testing at 4 separate time points; at rest, after a non-painful stimulus, after a painful stimulus, and 20-minutes after turning	Feasibility, criterion validity, discriminant validity, sensitivity and specificity, and internal consistency of the German CPOT	High clinical usability, excellent criterion validity, good discriminant validity, high sensitivity and specificity, and acceptable internal consistency

5. Isenberg, D. L., Kissman, K. M., Salinski, E. P., Saks, M. A., & Evans, L. B. (2018). Simple changes to emergency department workflow improve analgesia in mechanically ventilated patients. *Western Journal of Emergency Medicine, 19*(4), 668-674. https://doi.org/10.5811/westjem.2018.4.36879

Level: II

Purpose or Hypothesis	Type of Evidence and Research Design	Sample (population, size, setting)	Intervention Procedures	Primary Outcome/Measures	Results Conclusions
Evaluate the impact of altering the workflow of the emergency department to increase adherence to the SCCM's analgesia-first pain management guidelines	Cohort, pre-/ post-, retrospective design	Convenience sampling for all adult patients intubated while in the ED by emergency physicians, a total of 509 patients met inclusion criteria	Educational campaign followed by workflow changes to increase availability of analgesics within the emergency department and an EMR bundle that incorporated analgesia into mechanical ventilation order sets	Percentage of mechanically ventilated patients who received an opioid	Increased adherence to SCCM's analgesia-first guidelines

6. Kouhi, F., Froutan, R., & Moghaddam, A. (2023). Investigating the effect of the CPOT-based pain management program on the pain intensity and dose adjustment of analgesics in mechanically ventilated patients: A randomized clinical trial. *Nursing Practice Today, 10*(3), 208-218. https://doi.org/10.18502/npt.v10i3.13430

Level: I

Purpose or Hypothesis	Type of Evidence and Research Design	Sample (population, size, setting)	Intervention Procedures	Primary Outcome/Measures	Results Conclusions
To determine the effect of a structured pain management algorithm that utilized the CPOT and the impact on the frequency and dosing of analgesics among mechanically ventilated patients	Randomized clinical trial	70 adult patients admitted to two ICUs of Imam Reza Hospital in Mashhad, Iran. No mention of powered sample sizing.	Control: pain scores obtained using BPS and physiological indicators before, during, and after tracheal suctioning. Increase of >20% of each vital sign triggered the need for pain medication, dose and frequency determined by the physician. Intervention: Nurses trained on CPOT and management tool based on CPOT scores. CPOT scores obtained before, during, and after tracheal suctioning. Specific doses of fentanyl were given for specific CPOT scores	The dose of analgesia received as well as the CPOT score	BPS and CPOT had a strong correlation between the two pain instruments. Patients in the control group were given significantly fewer bolus doses of fentanyl but received much higher doses of continuous infusion fentanyl. Fentanyl consumption was significantly lower in the intervention group. The use of CPOT allowed for better pain management without oversedation compared to the BPS

7. Rijkenberg, S., Stilma, W., Bosman, R., van der Meer, N., & van der Voort, P. (2017). Pain measurement in mechanically ventilated patients after cardiac surgery: comparison of the behavioral pain scale (BPS) and the critical-care pain observation tool (CPOT). *Journal of Cardiothoracic and Vascular Anesthesia, 31*(4), 1227-1234. https://doi.org/10.1053/j.jvca.2017.03.013

Level: III

Purpose or Hypothesis	Type of Evidence and Research Design	Sample (population, size, setting)	Intervention Procedures	Primary Outcome/Measures	Results Conclusions
Compare the reliability, internal consistency, and discriminant validation of the BPS and CPOT in mechanically ventilated post-cardiac surgery patients	Prospective, observational cohort study with a repeated measurement design	Setting: 20-bed mixed medical/surgical/cardiac surgical ICU at a teaching hospital in Amsterdam, The Netherlands Sample: 72 mechanically ventilated post-cardiac surgery adult patients, as only those with complete scores were retained for inclusion	Education provided to bedside staff regarding CPOT and BPS scoring systems. Bedside RN screened patients for eligibility into study, bedside RN and colleague independently assessed CPOT or BPS during 4 pre-defined moments: at rest before a non-painful procedure, during a nonpainful procedure, at rest prior to a painful procedure, and during a painful procedure	Interrater reliability and discriminant validation between BPS and CPOT scores	Both BPS and CPOT are reliable and valid means to assess pain in mechanically ventilated post-cardiac surgical patients.

Table 2

Evidence Synthesis Table: Improving Pain Assessment in Mechanically Ventilated Adults Requiring Ground Transport

Project Title: Improving pain assessment in mechanically ventilated adults requiring transport			
PICOT: Among mechanically ventilated adults requiring transport, how does implementing a validated pain assessment tool intended for use in the patient population into the pain and sedation management protocol, compared to current practice (pain assessment using a pain tool not validated in the patient population), impact pain assessment?			
JHNEBP Model Level	**Total Number of Sources**	**Author and Quality Rating of each study**	**Synthesis of Findings**
Level 1 Experimental study · Randomized Controlled Trial (RCT)· Systematic review of RCTs with or without meta-analysis	2 RCTs	Dehghani et al., 2019 – High quality Kouhi et al., 2023 – Good quality	Both level I studies identify the need for standardization of pain assessment among mechanically ventilated patients utilizing a validated tool. Kouhi et al. did not communicate if their sample size was sufficient. Both studies were single-center, convenience sampling.
Level II Quasi-experimental studies · Systematic review of a combination of RCTs and quasi-experimental studies, or quasi-experimental studies only, with or without meta-analysis	3 Quasi-experimental studies	Avasrah, 2019 – High quality Bensen et al., 2019 – Good quality Isenberg et al., 2018 – Good quality	All level II studies identified were quasi-experimental, single-center studies. Ayasrah and Isenberg et al., determined a powered sample size, increasing their quality rating. Bensen et al., and Isenberg et al., were retrospective studies, which may limit the interventions' impact. All level II studies had consistent results demonstrating that the implementation of non-verbal pain scores to assess pain in mechanically ventilated patients decreased pain, improved compliance with clinical practice guideline standards, and improved patient outcomes.
Level III Non-experimental study · Systematic review of a combination of RCTs, quasi-experimental, and non-experimental studies, or non-experimental studies only, with or without meta-analysis · Qualitative study or systematic review of qualitative studies with or without meta-synthesis	2 Non-experimental observational studies	Emsden et al., 2018 – Good quality Rijkenberg et al., 2017 – Good quality	Both level III articles determined that BPS and CPOT pain scales are valid means of measuring pain in mechanically ventilated patients. Emsden et al.'s article focused on applying the CPOT to a heterogenous population and determined that it is feasible to validate the CPOT in a heterogeneous setting. Rikenberg et al. determined that both the BPS and CPOT are valid and reliable means of assessing pain in mechanically ventilated cardiac patients
Overall Quality Rating w/rational and Recommendation: Good and consistent evidence – practice change is warranted			

Table 3

SMART Goals and Measurement Strategies

Structure	Process	Outcome
CPOT will be integrated into the Pain and Sedation Management Protocol for patients with an advanced airway within 1 week of QI initiative go-live date.	All staff will be trained on the use of the CPOT within 2 weeks of QI initiative go-live date.	All mechanically ventilated adults requiring ground transport will be assessed for pain at the beginning and end of each transport using the CPOT within 4 weeks of implementation.
Measurement Strategies		
The department medical director will approve the updated protocol which incorporates the CPOT, and the protocol will be amended to include the CPOT. The updated protocol will be distributed to staff in both print and digital formats.	Staff will participate in simulation-based education where they will demonstrate competency with assessing and documenting using the CPOT. Staff will attest to completing education through the use of REDCap survey. REDCap survey responses will be compared to an active roster of employees. Staff will be provided opportunities for bidirectional feedback during training and throughout implementation.	The project lead will generate weekly audit reports to monitor adherence to the updated protocol to ensure all eligible patients are assessed for pain using the CPOT. Audit results will be entered into REDCap weekly. Audit results will be entered into Run Chart which will be displayed within the department on a bi-weekly basis.

Figure 1

Root Causes Analysis: Pain Assessment in Mechanically Ventilated Adults Requiring Ground Transport

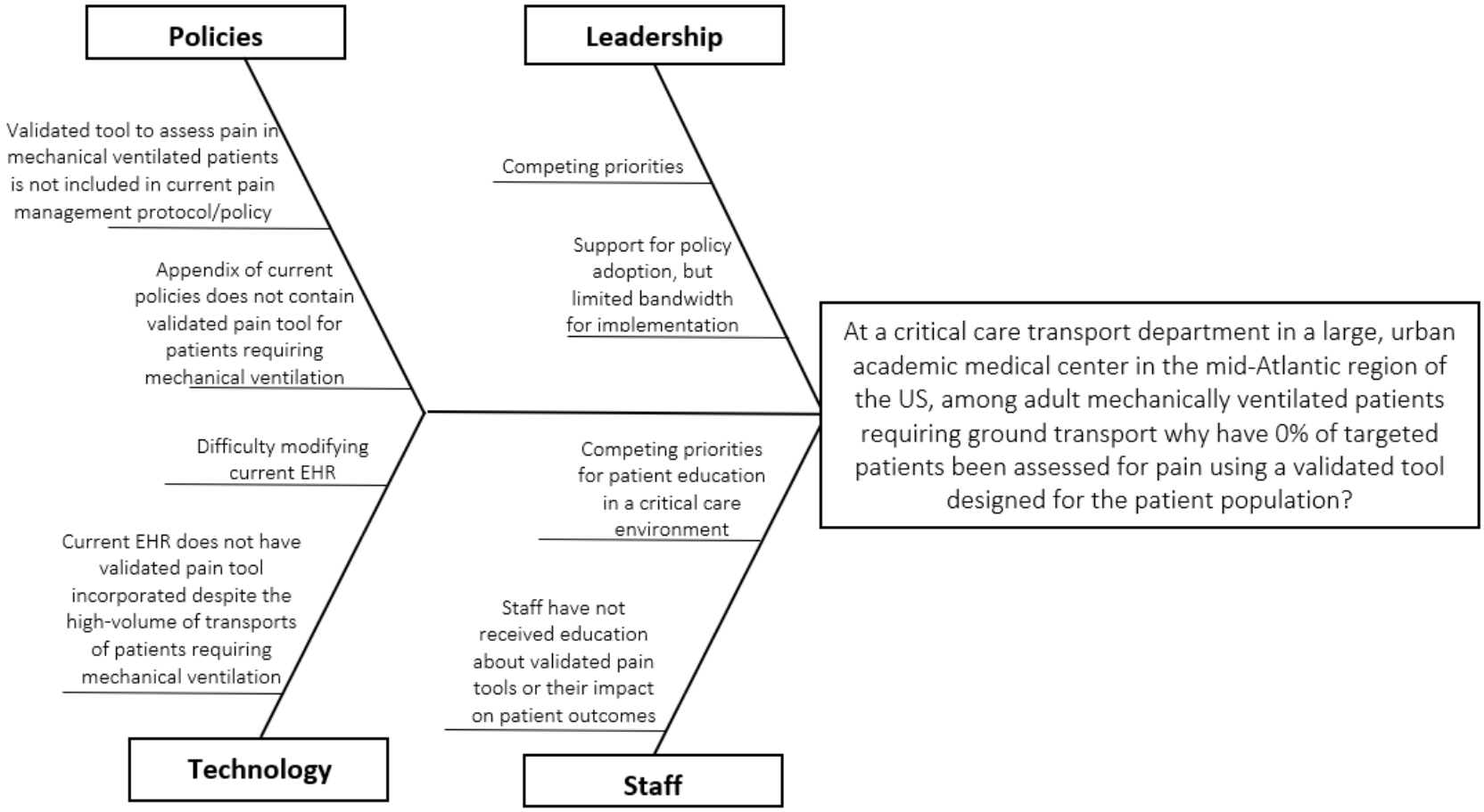


Figure 2

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)

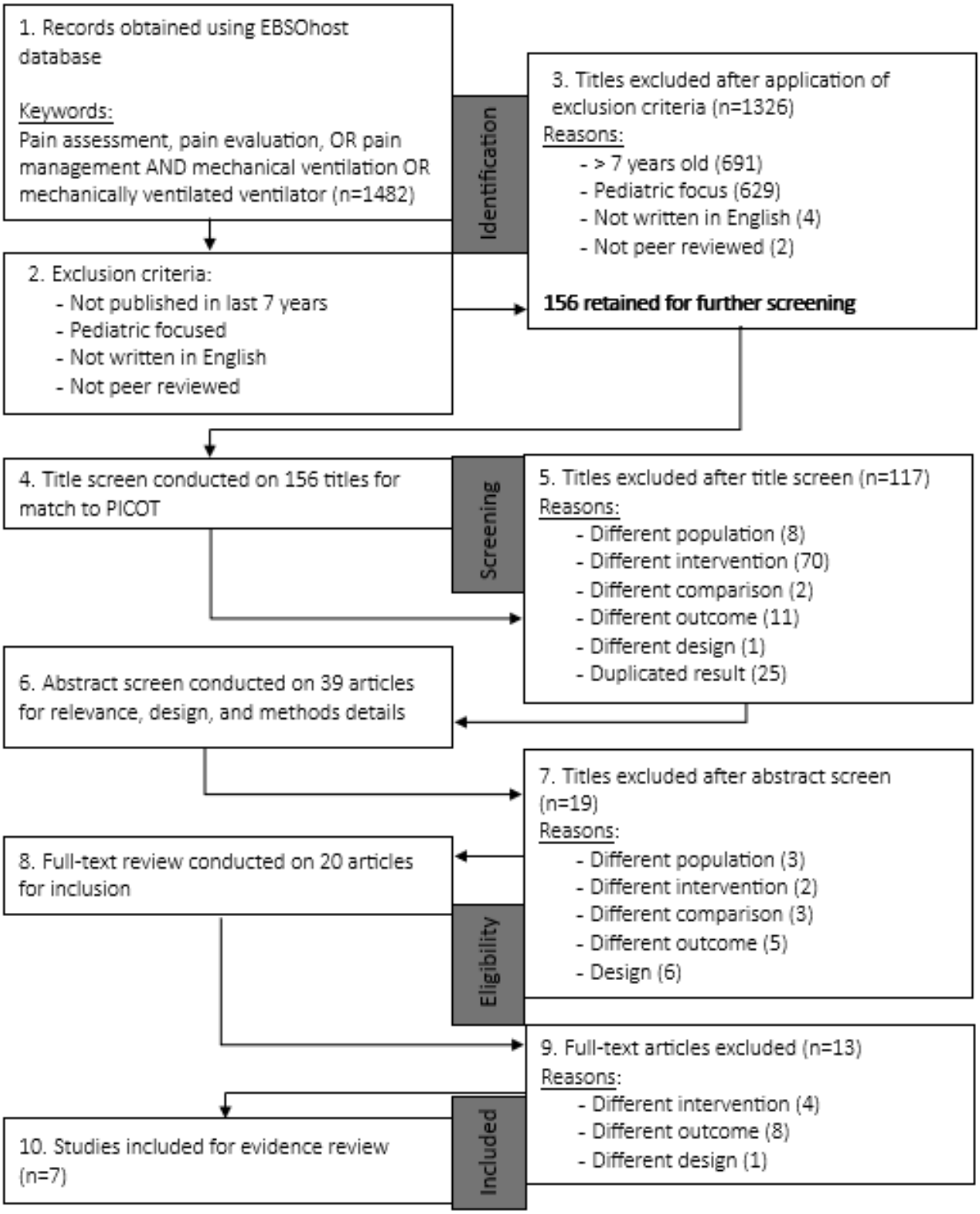
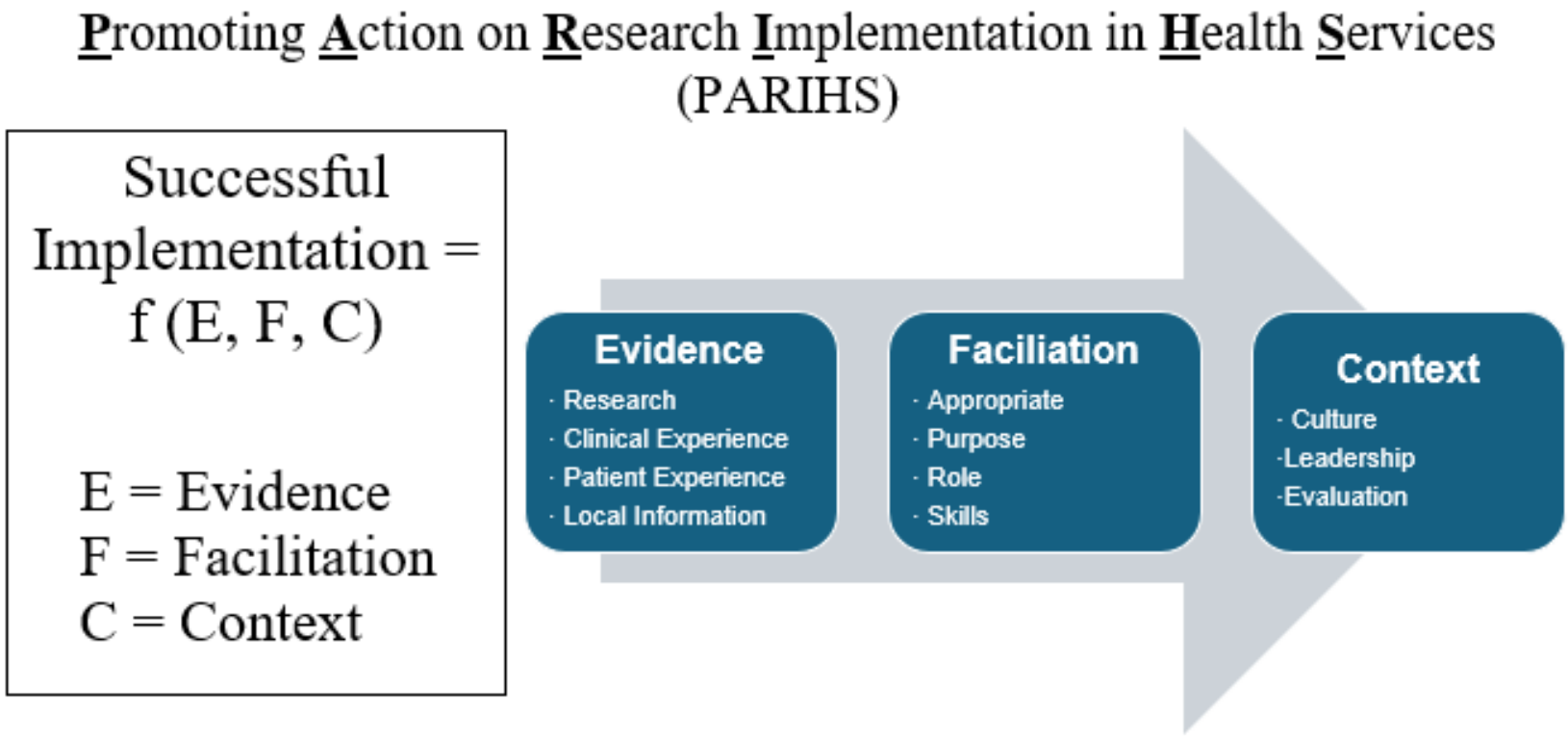


Figure 3

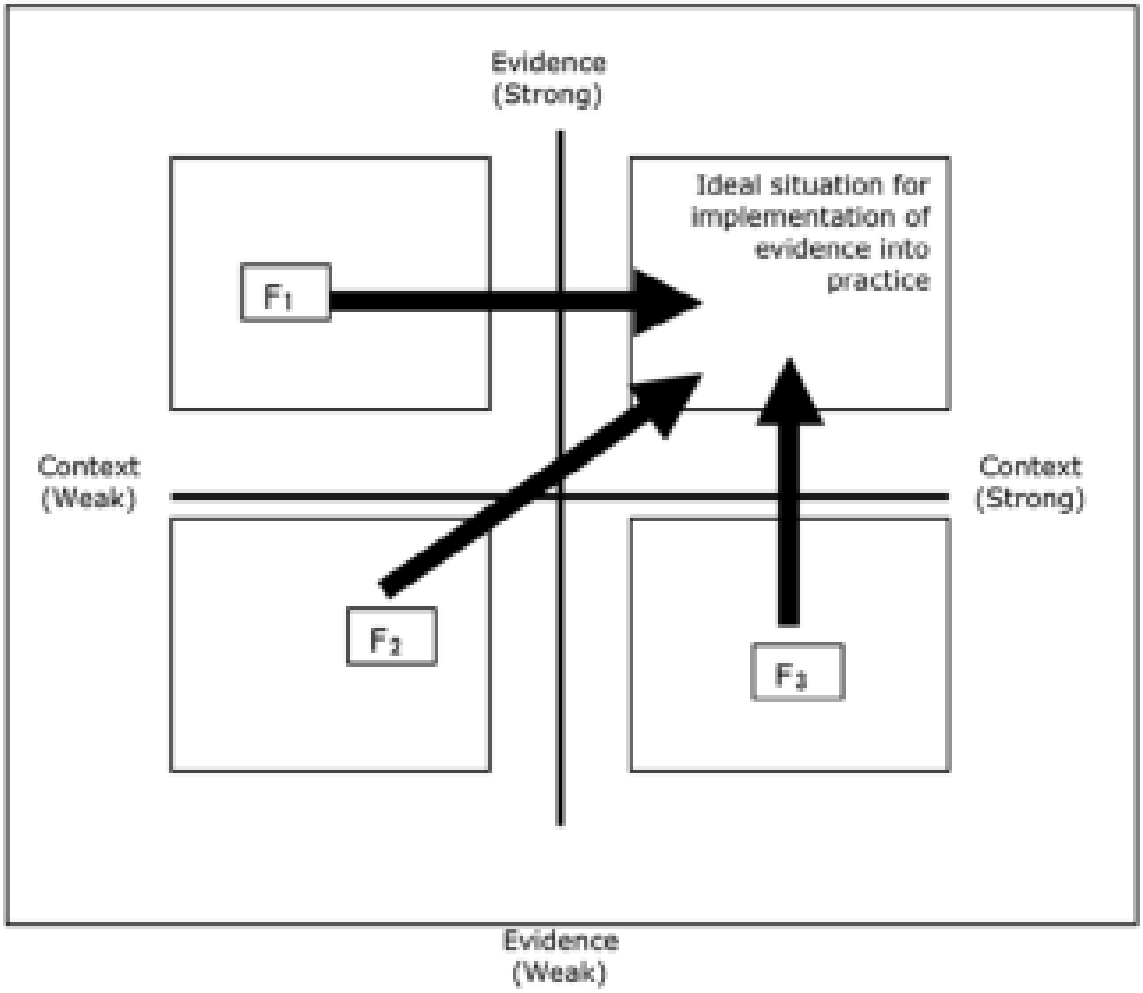
Promoting Action on Research Implementation in Health Services Framework – Diagram 1



Note. Adapted from "Evaluating the successful implementation of evidence into practice using the PARiHS framework: theoretical and practical challenges" by A. L. Kitson, J. Rycroft-Malone, B. McCormack, K. Seers, and A. Titchen, 2008, *Implementation Science,* 3(1) (https://doi.org/10.1186/1748-5908-3-1). Open access.

Figure 4

Promoting Action on Research Implementation in Health Services Framework – Diagram 2



Note. From "Evaluating the successful implementation of evidence into practice using the PARiHS framework: theoretical and practical challenges" by A. L. Kitson, J. Rycroft-Malone, B. McCormack, K. Seers, and A. Titchen, 2008, *Implementation Science,* 3(1) (https://doi.org/10.1186/1748-5908-3-1). Open access.

Figure 5

Process Map Prior to Implementation: Improving Pain Assessment in Mechanically Ventilated Adults Requiring Ground Transport

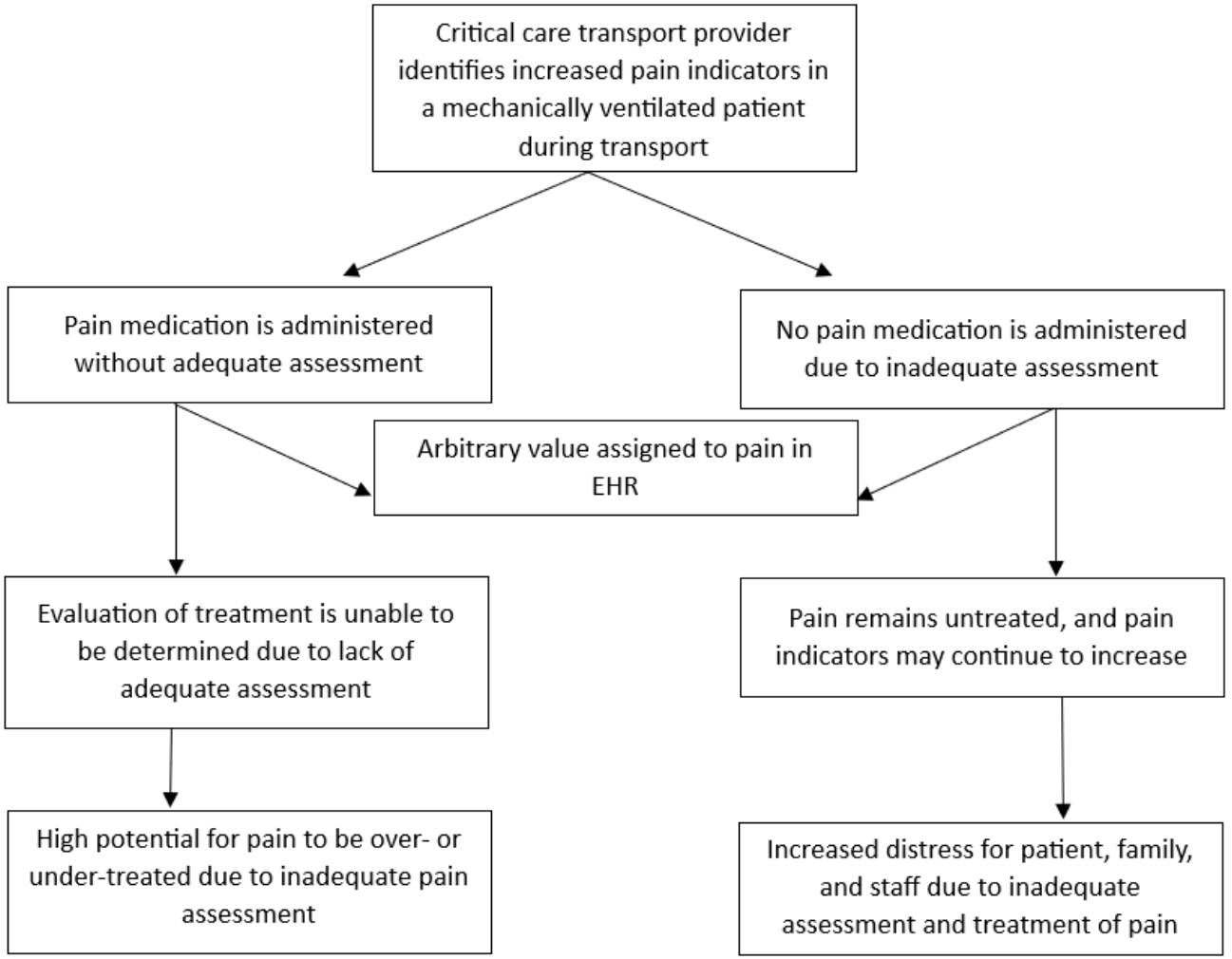


Figure 6

Desired Process Map: Pain Assessment in Mechanically Ventilated Adults Requiring Ground Transport

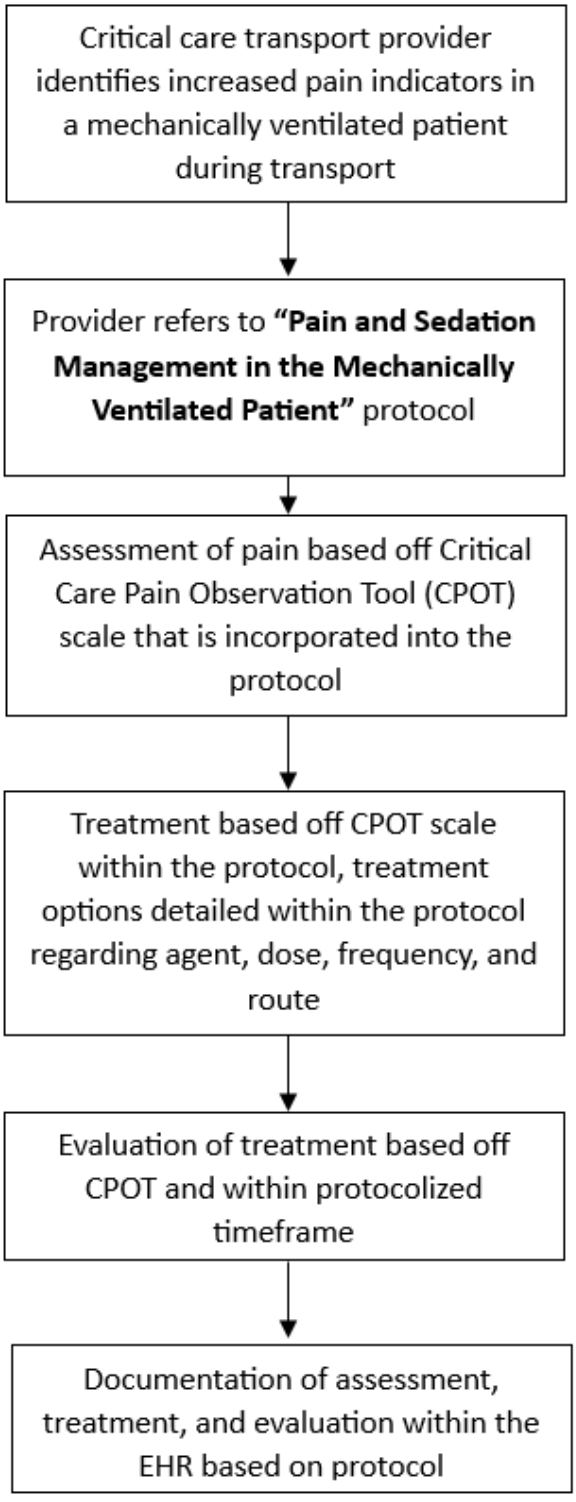


Figure 7

Context Assessment Index

Context Assessment Index (CAI)

For each of the following statements, put a cross only in one box only. SA – Strongly agree; A – Agree; D – Disagree; SD – Strongly Disagree		SA	A	D	SD
1	Personal and professional boundaries between HCPs are maintained	☐	☐	☐	☐
2	Decisions on care and management are clearly documented by all staff	☐	☐	☐	☐
3	A proactive approach to care is taken	☐	☐	☐	☐
4	All aspects of care/treatment are based on evidence of best practice	☐	☐	☐	☐
5	The nurse leader acts as a role model of good practice	☐	☐	☐	☐
6	HCPs provide opportunities for patients to participate in decisions about their own care	☐	☐	☐	☐
7	Education is a priority	☐	☐	☐	☐
8	There are good working relations between clinical and non-clinical staff	☐	☐	☐	☐
9	Staff receive feedback on the outcomes of complaints	☐	☐	☐	☐
10	HCPs in the MDT have equal authority in decision making	☐	☐	☐	☐
11	Audit and/or research findings are used to develop practice	☐	☐	☐	☐
12	A staff performance review process is in place that enables reflection on practice and goal setting and is regularly reviewed	☐	☐	☐	☐
13	Staff have explicit understanding of their own attitudes and beliefs toward the provision of care	☐	☐	☐	☐
14	Patients are encouraged to be active participants in their own care	☐	☐	☐	☐
15	There is high regard for patients' privacy and dignity	☐	☐	☐	☐
16	HCPs and health care support workers understand each other's role	☐	☐	☐	☐
17	The management structure is democratic and inclusive	☐	☐	☐	☐
18	Appropriate information (large written print, tapes, etc.) is accessible to patients	☐	☐	☐	☐
19	HCPs and patients work as partners, providing individual patient care	☐	☐	☐	☐
20	Care is based on a comprehensive assessment	☐	☐	☐	☐
21	Challenges to practice are supported and encouraged by nurse leaders and nurse managers	☐	☐	☐	☐
22	Discussions are planned between HCPs and patients	☐	☐	☐	☐
23	The development of staff expertise is viewed as a priority by nurse leaders	☐	☐	☐	☐
24	Staff use reflective processes (e.g., action learning, clinical supervision, or reflective diaries) to evaluate and develop practice	☐	☐	☐	☐
25	Organizational management has high regard for staff autonomy	☐	☐	☐	☐
26	Staff welcome and accept cultural diversity	☐	☐	☐	☐
27	Evidence-based knowledge on care is available to staff	☐	☐	☐	☐
28	Patients have choice in assessing, planning, an evaluating their care and treatment	☐	☐	☐	☐
29	HCPs have the opportunity to consult with specialists	☐	☐	☐	☐
30	HCPs feel empowered to develop practice	☐	☐	☐	☐
31	Clinical nurse leaders create an environment conducive to the development and sharing of ideas	☐	☐	☐	☐
32	Guidelines and protocols based on evidence of best practice (patient experience, clinical experience, and research) are available	☐	☐	☐	☐
33	Patients are encouraged to participate in feedback on care, culture, and systems	☐	☐	☐	☐
34	Resources are available to provide evidence-based care	☐	☐	☐	☐
35	The organization is non-hierarchical	☐	☐	☐	☐
36	HCPs share common goals and objectives about patient care	☐	☐	☐	☐
37	Structured programs of education are available to all HCPs	☐	☐	☐	☐

Note. Adapted from "Development and testing of the context assessment index (CAI)" by B. McCormack, G. McCarthy, J. Wright, P. Slater, and A. Coffey, 2009, *Worldviews on Evidence-Based Nursing, 6*(1) (https://doi.org/10.1111/j.1741-6787.2008.00130.x). Copyright 2009 by Sigma Theta Tau International.

Appendix A

Pain and Sedation Management Protocol For Patients With An Advanced Airway

[redacted] **Critical Care Transport Protocols: Sedation Management -Advanced Airway**

SEDATION MANAGEMENT - ADVANCED AIRWAY

INCLUSION:

1. All patients with an advanced airway (e.g. endotracheal tube, supraglottic airway, tracheostomy)

EXCLUSION:

1. Patients who are hemodynamically unstable (MAP < 65 mmHg)

PROTOCOL:

1. All patients should receive ongoing assessment and documentation of sedation using the Richmond Agitation Sedation Score (RASS) (p.148) at least every 10 minutes (see below).
    a. Goal for adequate sedation is a RASS Score of -4.
2. All patients should receive ongoing assessment and documentation of pain using the Critical Care Pain Observation Tool (CPOT) (p.191) at least every 10 minutes.
    a. A goal for adequate pain control is a CPOT of ≤2.
3. If not at goal RASS -4 **AND** CPOT ≤2, **initiate** the following if MAP is > 70:

Medication	Initial Dose	Notes
Propofol	20mcg/kg/min	Range 10-80 mcg/kg/min
Fentanyl	• 1 mcg/kg IV push • Max dose 100 mcg/kg • If patient is >69 years old, administer Fentanyl at 0.5 mcg/kg IVP	**Use pain medications in conjunction with sedative agents for pain control** (may not be required with Ketamine)

4. For interfacility transfers, you may **continue** opioid or benzodiazepine infusions. Propofol and/or dexmedetomidine (Precedex) drips already initiated may be maintained within the following parameters:
    a. Propofol – if MAP < 65 mmHg, or a 20% drop in MAP, consider 250 mL NS bolus and reduce propofol infusion by half.
    b. Dexmedetomidine (Precedex) – Can cause bradycardia and/or hypotension
        i. If HR < 50, consult MEDICAL COMMAND.
    c. If sending facility is unable to send an adequate volume of medications for transport, coordinate with Lifeline Medical Command Physician for transition to a different sedation modality (Fentanyl, Versed, Ketamine, Propofol).

MEDICATION BOLUS/TITRATION TABLE FOR SEDATION			
Medication	**Bolus Dosing**	**Titration**	**Maintenance Dosing**
Call Medical Command if dosing outside of these ranges			
Propofol	N/A	Titrate by 10 mcg/kg/min every 5 minutes If hypotensive, decrease Propofol drip by 50% and consider fluid bolus	10-80 mcg/kg/min

[redacted] Critical Care Transport Protocols: Sedation Management -Advanced Airway

Continuation of Sedation Medication Table			
Medication	**Bolus Dosing**	**Titration**	**Maintenance Dosing**
Dexmede-tomidine (Precedex)	N/A	Titrate by 0.1 mcg/kg/hr every 10 minutes	0.2 – 1.5 mcg/kg/hr
Fentanyl	• 1 mcg/kg IV every 10 minutes x 3 doses • Max single dose 100 mcg • If patient is >69 years old, administer 0.5 mcg/kg	• Titrate by 25 mcg every 10 minutes. • If drip rate is < 100 mcg/hr, consider discontinuing and give boluses per Pain Protocol for transport. • If patient requires titration outside of above parameters or if patient is hypotensive but not at a CPOT ≤2, **AND** RASS of -4, contact MEDICAL COMMAND	25-200 mcg/hr
Midazolam (Versed®)	• 0.1 mg/kg IV every 10 minutes x 2 doses • Max single dose 2 mg	Titrate by 2 mg/hr every 30 minutes	1-10 mg/hr
Ketamine **MEDICAL CONSULT REQUIRED**	• 1 mg/kg IV/IO every 20 minutes as needed • Max single dose 100 mg)	Titration per MEDICAL COMMAND	0.1-1 mg/kg/hr

5. Paralytic infusions initiated by sending facility may be maintained within the following parameters provided adequate sedation and pain management:

Obtain most recent train of four (should be 1-2 twitches out of 4) **MEDICATION TITRATION TABLE FOR PARALYTIC DRIPS FROM SENDING FACILITY**		
Medication	**Titration**	**Maintenance Dosing**
Call Medical Command if dosing outside of this range.		
Cisatracurium (Nimbex)	Titrate by 1 mcg/kg/min every 15 minutes	1-3 mcg/kg/min
Vecuronium (Norcuron)	Titrate by 0.3 mcg/kg/hr every 10 minutes	0.8 - 1.7 mcg/kg/hr

6. If initiation of chemical paralysis is required, obtain **MEDICAL CONSULT**.
    a. Administer Vecuronium 0.1 mg/kg IV x1 dose (10 mg maximum) **AFTER the administration of sedation**.
    b. **MEDICAL COMMAND** may also request initiation of paralytic infusion.

Appendix B

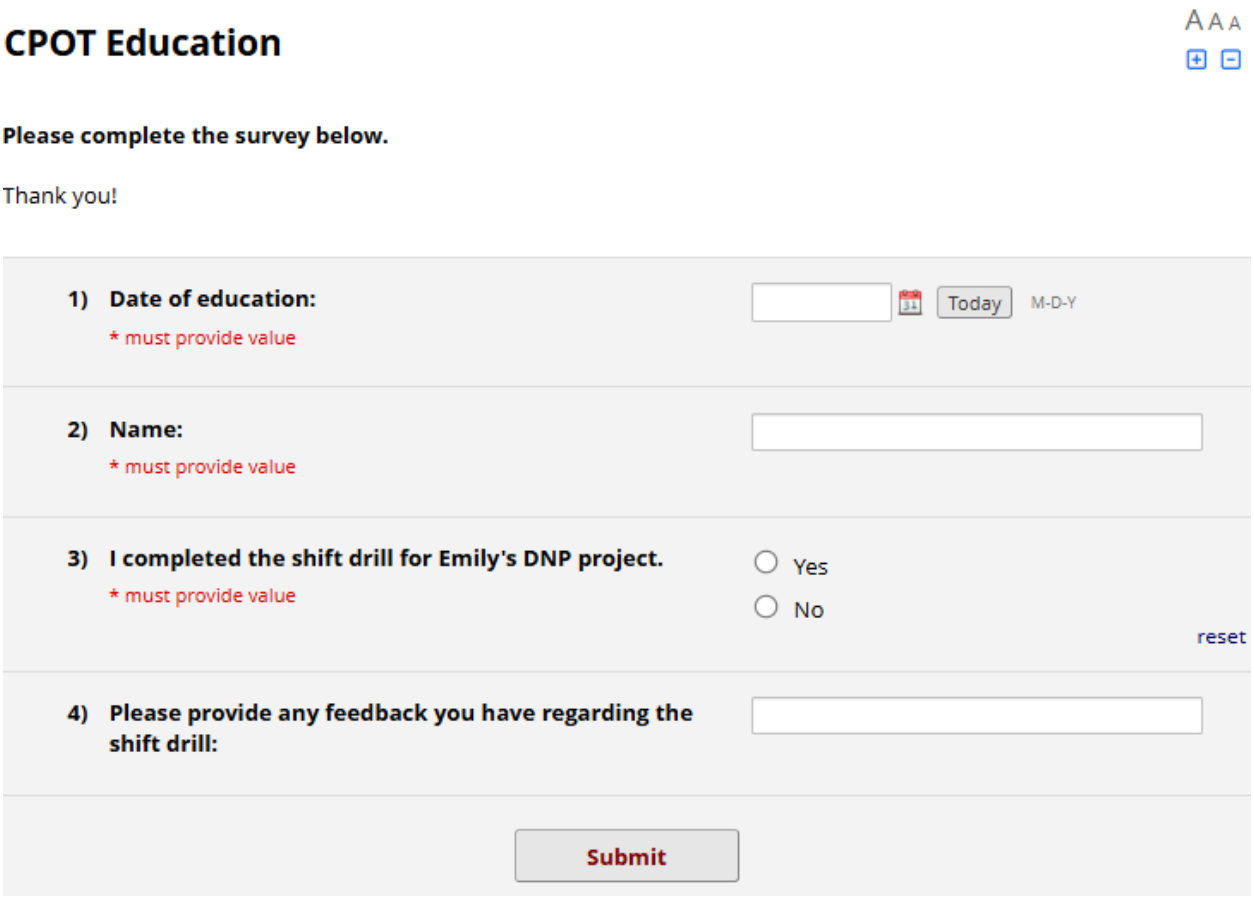
Critical-care Pain Observation Tool (CPOT) Protocol Appendix

Compliance with ventilator	
Tolerating ventilator or movement - Alarms not activated, easy ventilation	0
Coughing but tolerating - Alarms stop spontaneously	+1
Fighting ventilator - Asynchrony: blocking ventilation, alarms frequently activated	+2
Facial expression	
Relaxed, neutral - No muscular tension observed	0
Tense - Presence of frowning, brow lowering, orbit tightening	+1
Grimacing - All of the above facial movements plus eyelids tightly closed	+2
Body movements	
Absence of movements - Does not move at all (does not necessarily mean the absence of pain)	0
Protection - Slow, cautious movements, touching or rubbing at the pain site, seeking attention through movements	+1
Restlessness - Pulling tube, attempting to sit up, moving limbs, thrashing, not following commands	+2
Muscle Tension	
Relaxed - No resistance to passive movements	0
Tense, rigid - Resistance of passive movements	+1
Very tense or rigid - Strong resistance to passive movements; inability to complete movements	+2

Note. Adapted from "Validation of the critical-care pain observation tool in adult patients" by C. Gelinas, L. Fillion, K. A. Puntillo, C. Viens, and M. Fortier. 2006, *American Journal of Critical Care, 15*(4) (https://doi.org/10.4037/ajcc2006.15.4.420).

Appendix C

Staff Education Data Collection Tool



CPOT Education

AAA

Please complete the survey below.

Thank you!

1) Date of education:
* must provide value
Today M-D-Y

2) Name:
* must provide value

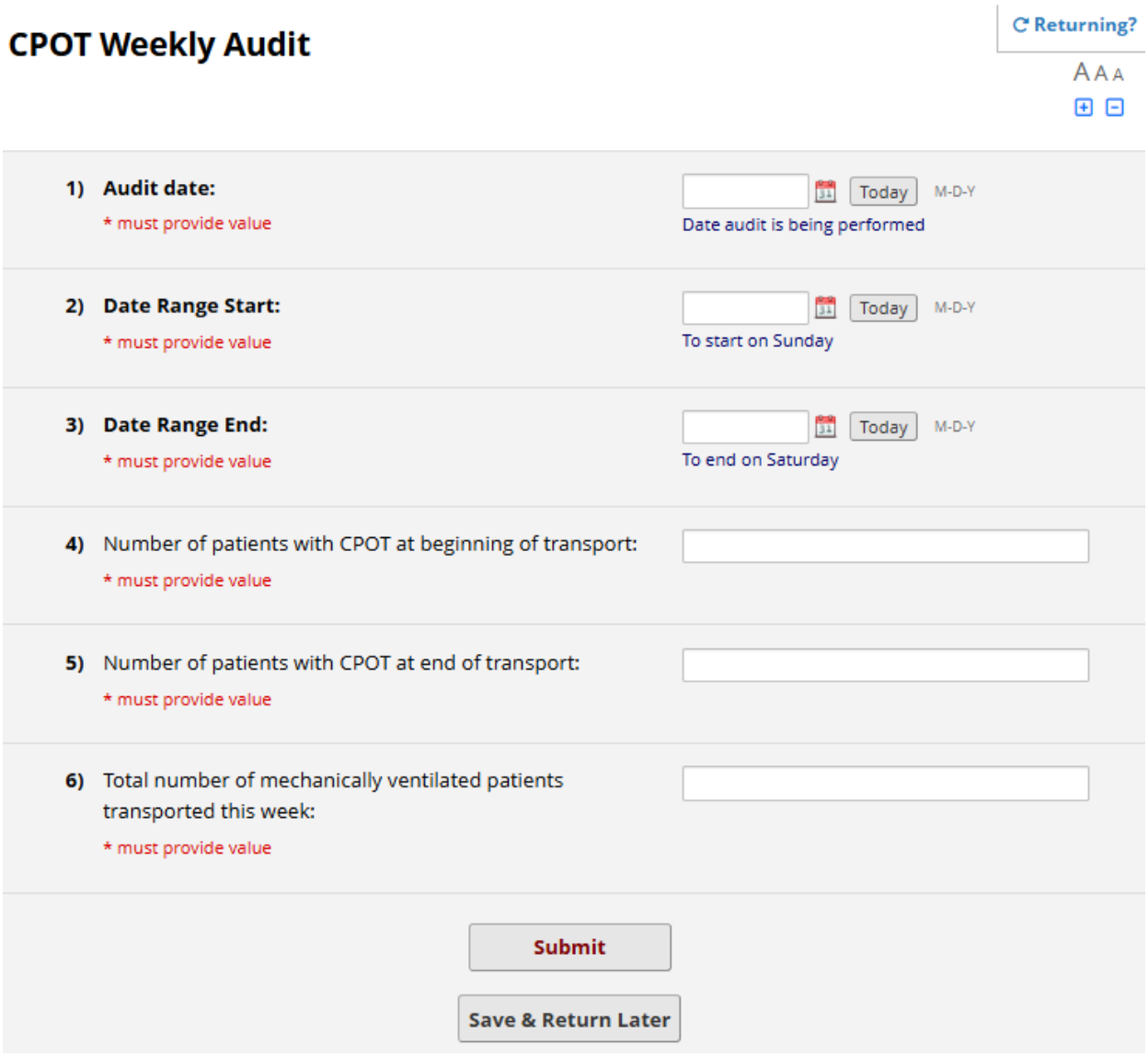
3) I completed the shift drill for Emily's DNP project.
* must provide value
Yes
No
reset

4) Please provide any feedback you have regarding the shift drill:

Submit

Appendix D

Weekly Audit Data Collection Tool



CPOT Weekly Audit

Returning?

AAA

1) **Audit date:** Today M-D-Y
* must provide value
Date audit is being performed

2) **Date Range Start:** Today M-D-Y
* must provide value
To start on Sunday

3) **Date Range End:** Today M-D-Y
* must provide value
To end on Saturday

4) Number of patients with CPOT at beginning of transport:
* must provide value

5) Number of patients with CPOT at end of transport:
* must provide value

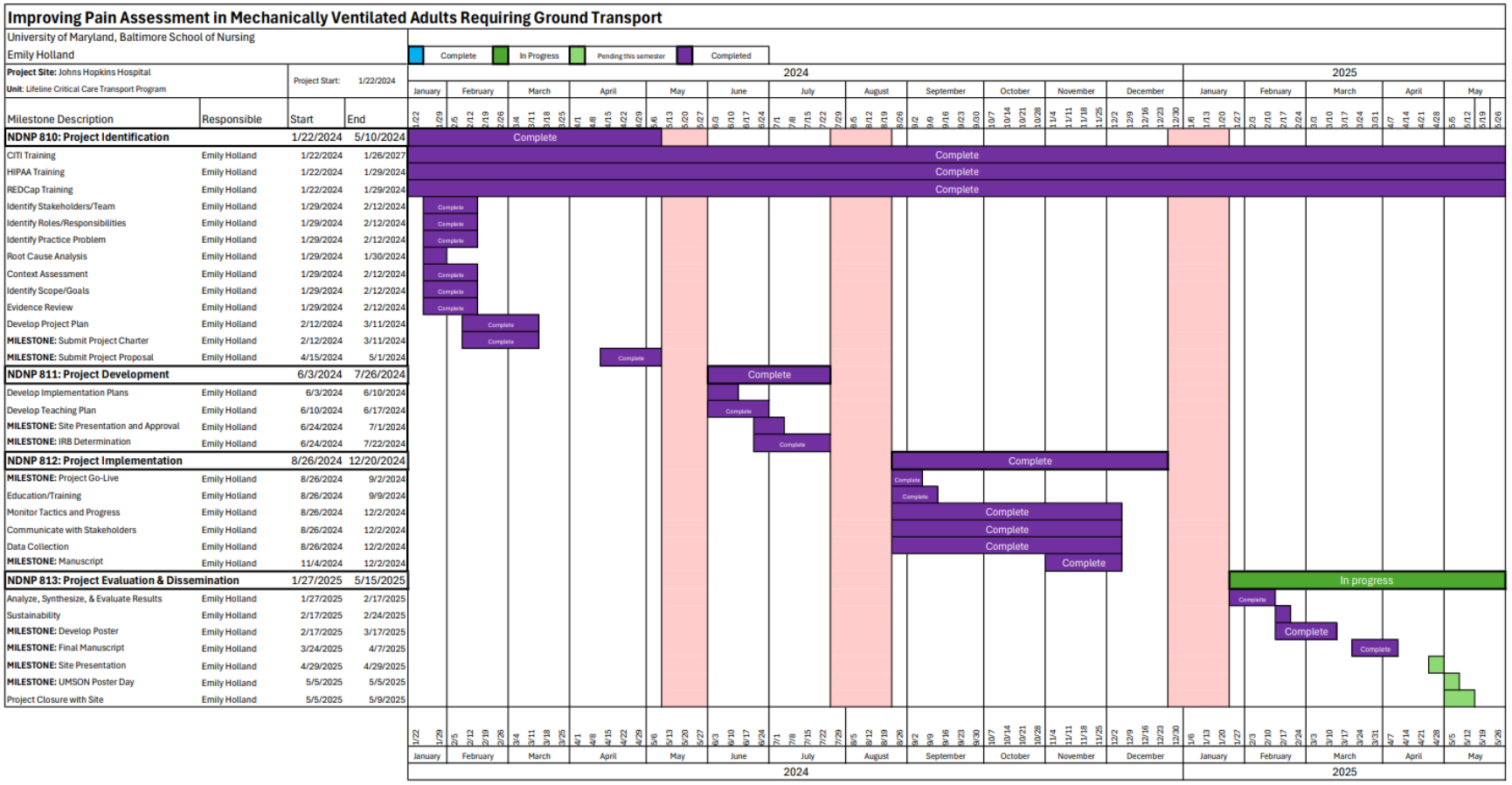
6) Total number of mechanically ventilated patients transported this week:
* must provide value

Submit

Save & Return Later

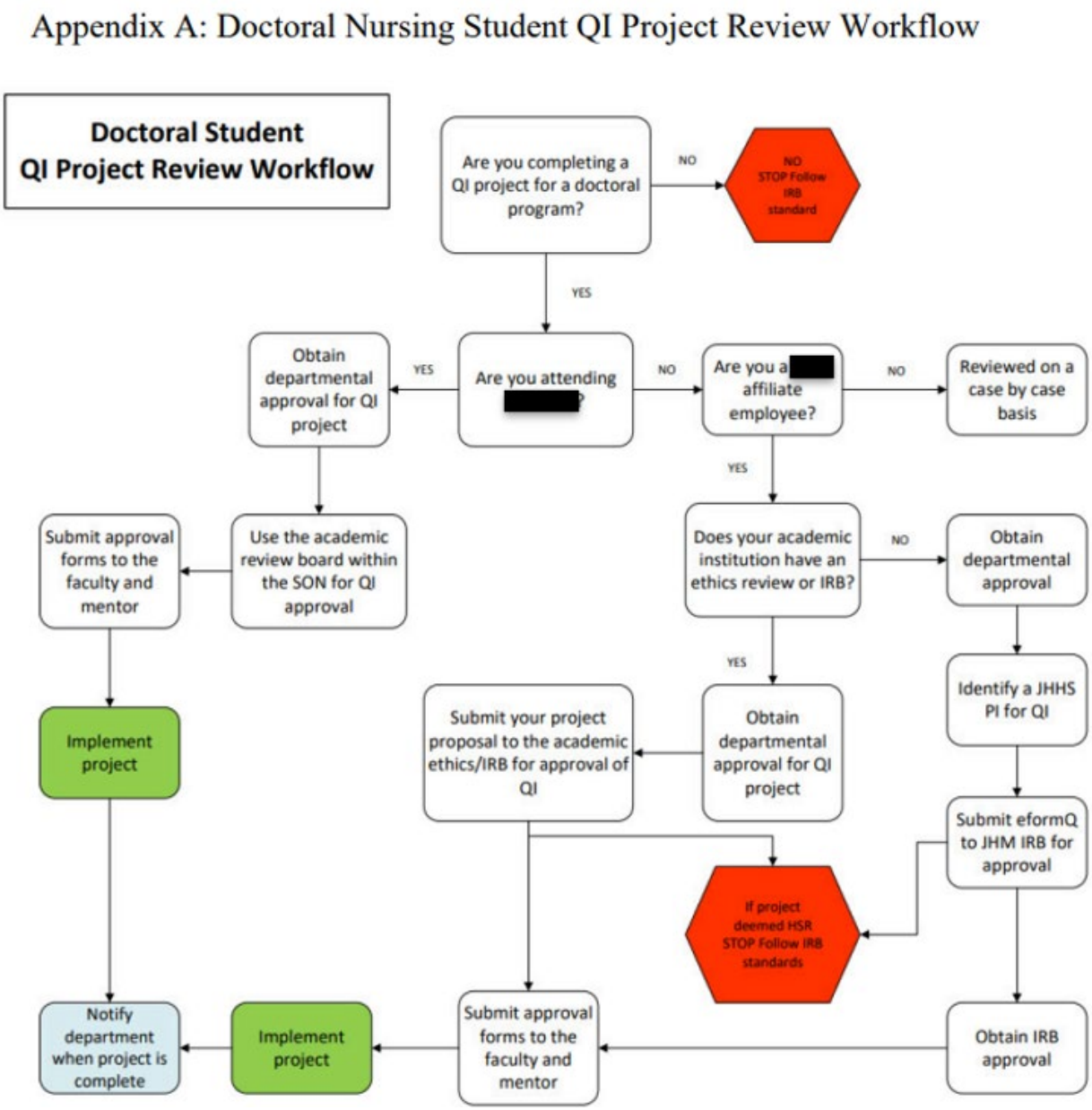
Appendix E

GANTT Chart - Improving Pain Assessment in Mechanically Ventilated Adults Requiring Ground Transport



Appendix F

Facility IRB Approval Flow Chart



Appendix G

CITI Training Certificates

CITI PROGRAM

Completion Date 30-Jan-2021
Expiration Date 30-Jan-2024
Record ID 40648043

This is to certify that:

Emily Holland

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Course In The Protection of Human Subjects
(Curriculum Group)
Group 1.Biomedical Research Investigators and Key Personnel.
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

University of Maryland Baltimore

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wacb2f707-8e6a-4058-a7b7-869c678b5164-40648043

Appendix H

CITI Training Certificates

CITI PROGRAM

Completion Date 26-Jan-2024
Expiration Date 26-Jan-2027
Record ID 59421528

This is to certify that:

Emily Holland

Not valid for renewal of certification through CME.

Has completed the following CITI Program course:

Course In The Protection of Human Subjects
(Curriculum Group)
Group 1.Biomedical Research Investigators and Key Personnel.
(Course Learner Group)
2 - Refresher Course
(Stage)

Under requirements set by:

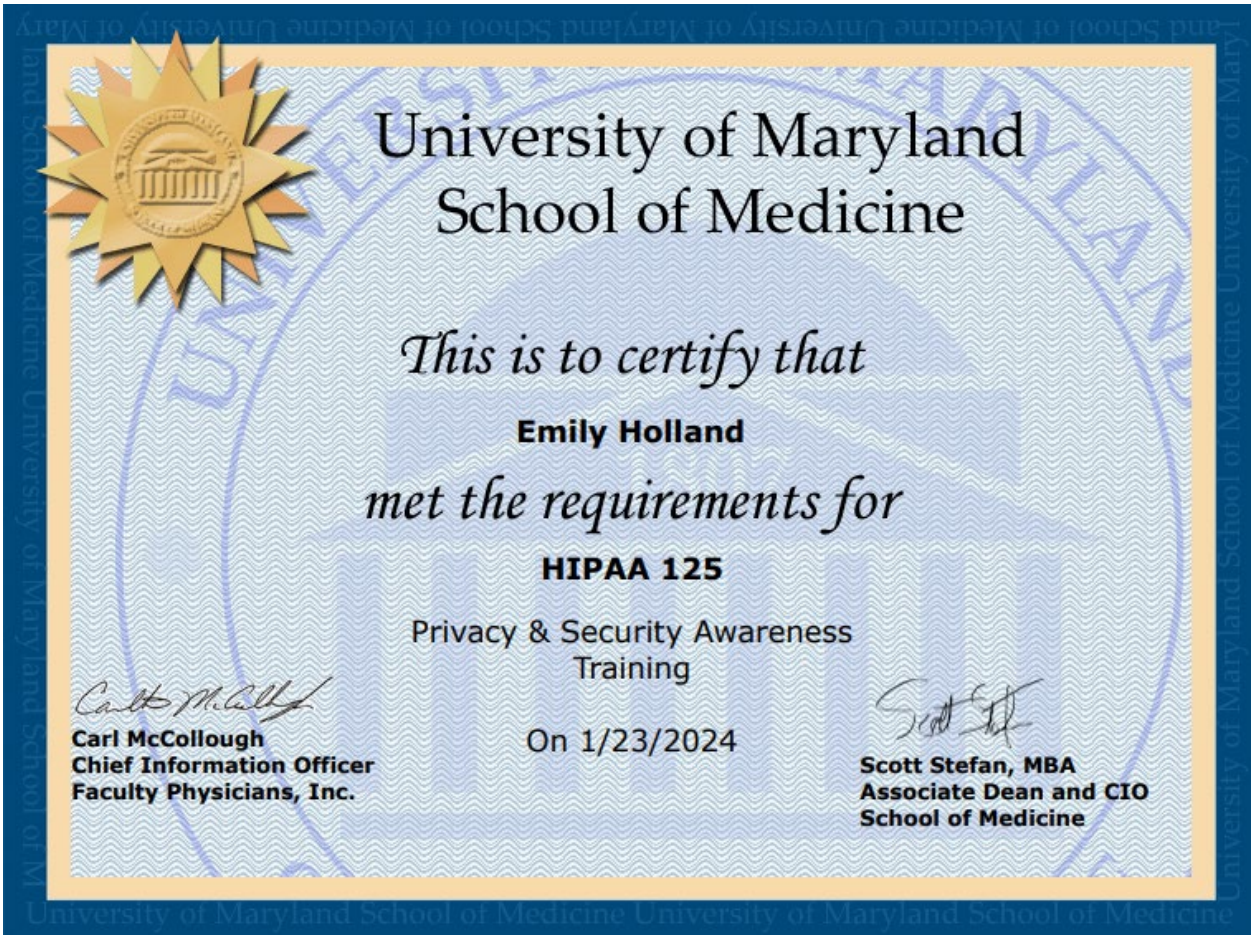
University of Maryland Baltimore

CITI
Collaborative Institutional Training Initiative
101 NE 3rd Avenue, Suite 320
Fort Lauderdale, FL 33301 US
www.citiprogram.org

Generated on 26-Jan-2024. Verify at www.citiprogram.org/verify/?w40ba84a4-11b2-4e9f-ad6f-c79b678faab3-59421528

Appendix I

HIPAA Training Certificates



Appendix J

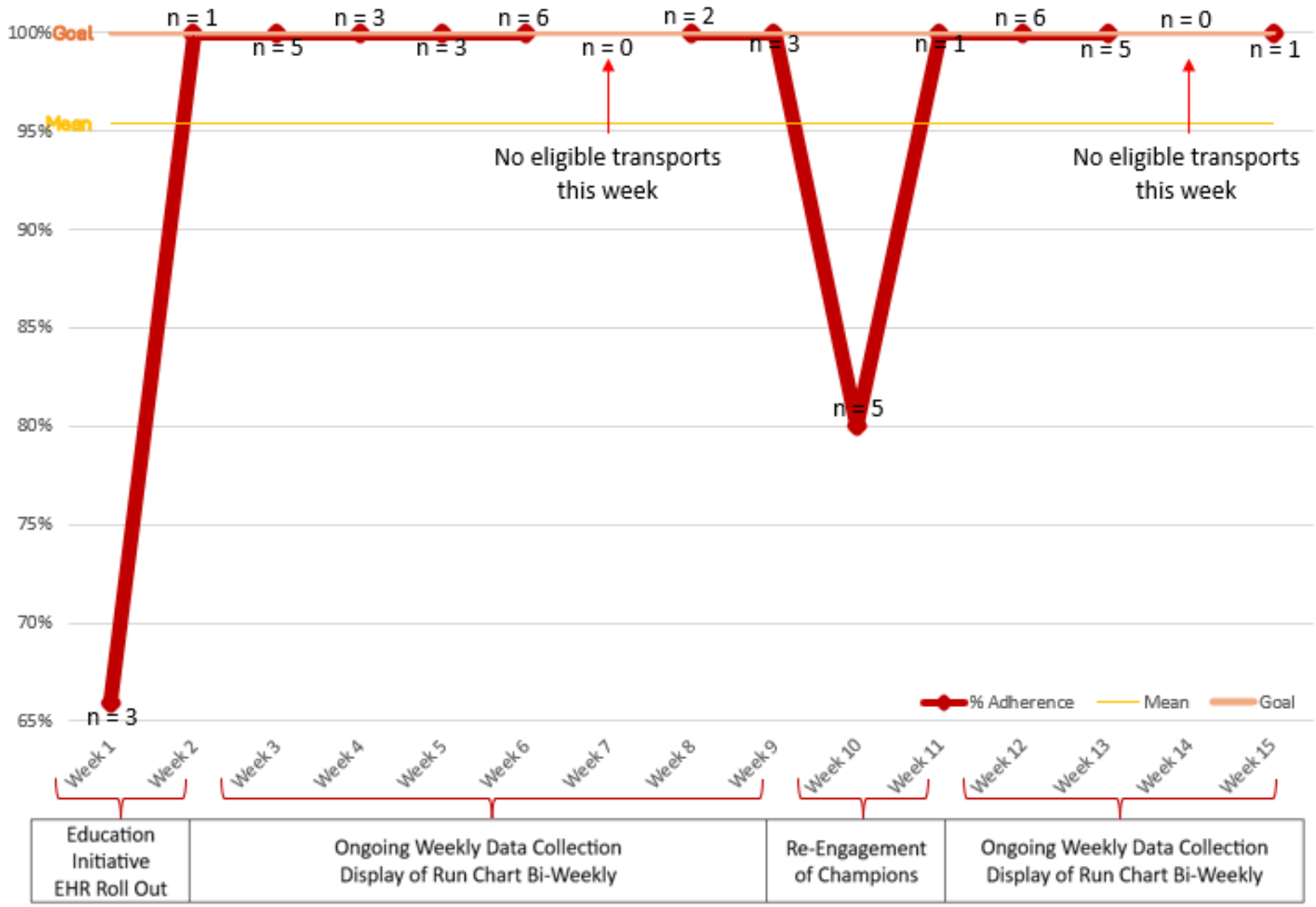
HIPAA Training Certificates

Appendix K

HIPAA Training Certificates

Appendix L

Run Chart: Improving Pain Assessment in Mechanically Ventilated Adults Requiring Ground Transport



Appendix M

MOCHA Sustainability Plan

Sustainability Planning

	Measurement	
M	- What will we continue to measure - What will we stop measuring	- Adherence to protocol - Staff education, will be incorporated into orientation
	Ownership	
O	- Who will own the new standard of work?	- QA personnel will be responsible for monitoring adherence and providing feedback to staff not adhering to the protocol
	Communication & Training	
C	- How will we communicate about the change and who will be the messengers? - How will we support individuals in the new "right way"? - What type of training will we use?	- CPOT will remain in the protocol, new staff will be instructed on the use and documentation during orientation - Preceptors will be responsible for ensuring competence
	Hardwiring the Change	
H	- How will we make it hard to do the wrong thing and easy to do the right thing? o Can we reduce reliance on human memory? - How will we standardize? o Do we need new documentation and resources?	- The QA process will provide audit/feedback to specific staff who fail to adhere to protocol - The protocol will refer to the CPOT appendix contained in the protocol book - The CPOT will remain integrated into the EHR
	Assessment of Workload	
A	- Are our changes increasing the overall workload on the system?	- The utilization of this tool will not increase the overall workload on the system

Note. Adapted from "Sustainability planning worksheet" by Institute for Healthcare Improvement, 2019, *IHI Tool.* Retrieved April 21, 2025, from https://www.ihi.org/resources/tools/sustainability-planning-worksheet