Implementation of a Geriatric Rib Fracture Pathway in Trauma

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Abstract

PROBLEM: Geriatric trauma patients who have sustained rib fractures are at increased risk for pulmonary dysfunction, prolonged hospitalization, and death. The current literature supports a standardized care approach of evidence-based interventions in this patient population to help improve outcomes. Leadership of a large academic Level 1 Trauma Center, with the highest admission rate of adult traumas in the state, recognized poorer outcomes in geriatrics with rib fractures, and preliminary collated data showed a significant lack of established evidence-based practices on the Trauma Critical Care Unit. **PURPOSE**: The purpose of this quality improvement (QI) project was to implement and evaluate the use of an evidence-based rib fracture pathway in the geriatric trauma population to determine the compliance of pathway use by staff and possible effects on patient outcomes. **METHODS**: The project was implemented over a 14-week period from September to December 2020, after the completion of education and training of all staff on the Trauma Critical Care Unit. Eligible patients included patients aged 65 years and older with two or more rib fractures without high risk of respiratory complications due to admitting injury. Weekly chart audits were performed to assess compliance of the geriatric rib fracture pathway based on provider orders placed within 24 hours of admission and nursing documentation of pain assessments, deep breathe and cough, and incentive spirometry. **RESULTS**: Before the implementation of the project, 85% of nurses (n=49) and 100% of providers (n=12) completed the necessary education and training of the Geriatric Rib Fracture Pathway. After competency training, there was an increase in staff compliance with all components of the pathway including provider orders placed within 24 hours ($p<.001$) and documentation of the following nursing interventions – pain assessment ($p=.068$), deep breathe and cough ($p<.001$), and incentive spirometry ($p=.006$). **CONCLUSIONS**: This

pilot QI project suggested an increase in staff compliance with the implementation of a rib fracture pathway for geriatric trauma patients after completion of staff education and training. The Geriatric Rib Fracture Pathway is a safe and useful tool in identifying this target population, as well as in early adoption of evidence-based interventions to improve patient outcomes.

Introduction

Rib fractures are one of the leading injuries sustained in blunt traumas (Braset et al., 2016). The geriatric population, defined as 65 years and older, is particularly vulnerable and projected to encompass almost half of all trauma patients by 2060 (Office of Disease Prevention and Health Promotion, 2019). The physiology of the injury along with the associated pain creates complications such as reduced pulmonary function, prolonged hospitalization, and mortality (Sahr, 2013). A landmark study conducted by Bulger and colleagues (2000) found that not only are geriatric adults especially susceptible to rib fractures during trauma as a result of the physical changes that occur with aging, but their risk of morbidity and mortality are doubled compared to that of younger trauma patients with similar injuries. Major associations, such as the Western Trauma Association, recommend standardized management of trauma patients with rib fractures with evidence-based practices to optimize results (Brasel et al., 2016). The trauma critical care unit, specific to this project, is within a large, academic urban medical center that admits the largest number of adult trauma patients within the area. Leadership and key stakeholders within the institution identified a lack of consistent practice in this patient population resulting in increased rates of respiratory complications, uncontrolled pain, length of hospitalization, and mortality.

The purpose of this quality improvement (QI) project was to implement and evaluate the use of an evidence-based rib fracture pathway in the geriatric trauma population on the Trauma Critical Care Unit. The primary goal of the project included compliance with the implementation of the Geriatric Rib Fracture Pathway by the staff, with secondary goals of reducing the rates of hospital-acquired pneumonia and unplanned intubations.

Literature Review

A thorough literature search was conducted to discover the evidence supporting a multidisciplinary pathway for rib fracture management in the geriatric trauma population. The focus of the literature review was to identify the evidence to support a rib fracture pathway, specifically in the geriatric trauma population, to include interdisciplinary interventions such as pain assessment and management, respiratory care (incentive spirometry and cough and deep breathe), and medication management. The level of evidence was decided using Melnyk and Fineout-Overholt's (2014) rating system, while the quality of evidence was establishing using Newhouse's (2006) quality of evidence rating system (Tables 1 and 2).

The following studies researched the effects of respiratory interventions on patient outcomes. Chiumello et al. (2013) and Duggal et al. (2013) conducted systematic reviews and meta-analysis and found that noninvasive ventilation (NIV) results in positive clinical outcomes in adult patients with chest trauma such as reduced mortality, intubation rates, hospital and intensive care lengths of stay, complications, infections and better pulmonary function. Another study by Sum et al. (2019) found that the use of incentive spirometry (IS) resulted in lower prevalence of pulmonary complications (atelectasis, pneumonia, hemothorax, and pneumothorax), improved pulmonary function, and decreased hospital length of stay in adult patients with rib fracture(s) compared to not using an IS. Butts et al. (2017) and Carver et al. (2015) found that vital capacity may have predictive value in determining outcomes with patients with fractured ribs.

Pain was another major challenge in geriatric trauma patients with rib fractures. Galvagno et al. (2019) conducted a systematic review and meta-analysis of current literature and found that patients with blunt thoracic trauma had better clinical outcomes (i.e., pain scores, mortality hospital and ICU length of stay, postoperative pulmonary complications, need for mechanical ventilation, and pulmonary function tests) with epidural analgesics and multimodal analgesics (i.e., use of a combination of analgesics) compared to opioids alone. Rafiq et al. (2014) found that the use of multi-modal pain therapy versus only morphine analgesics had a significant decrease in average pain scores postoperatively, as well as a decrease in overall in-hospital adverse events such as cardiac, neurological, and gastrointestinal complications. Wei et al. (2019) found that implementation of a multi-modal pain regimen (MMPR) significantly reduced opioid exposure both inpatient and need at discharge. It also positively impacted numeric pain scale ratings and reduced unplanned intubations.

Lastly, the following studies looked at the implementation of a clinical pathway in the geriatric trauma population with rib fractures. In the landmark study, Todd et al. (2006) found that a multidisciplinary clinical pathway that included interventions from respiratory therapy, nursing, providers, physical therapy, nutrition, and pain services significantly reduced pneumonia and mortality rates in older patients with greater than four rib fractures. Kelley et al. (2017) found that implementation of a chest trauma protocol that incorporated a multidisciplinary approach to care with involvement from providers, respiratory therapy, and nursing significantly reduced unplanned ICU admissions and pneumonia rates.

The overall quality of evidence of the studies were low due to small sample sizes, study design, and lack of generalizability. Despite the low quality of evidence, the results of the all the studies were consistent in demonstrating positive outcomes with their intended interventions. A clinical pathway for rib fracture management in the geriatric trauma population promoted interventions that were easily attainable and had minimal risk with a potential of high benefits in patient outcomes.

Theoretical Framework

The Health Belief Model (HBM) was developed to understand how people participate in programs that prevent and detect disease. The HBM suggested that a person's beliefs in both the dangers of an illness or disease and usefulness of the required health action would determine the probability of the person adopting that behavior (LaMorte, 2019). Four factors influenced the change in health-related behavior. These included the severity of a potential illness, the person's susceptibility to that illness, the benefits of preventative action, and the barriers to change (Jones et al., 2015).

The components of this model were applicable to the background and success of implementation of the geriatric rib fracture pathway in the trauma population. Although the HBM model was typically used to look at modifying patient behaviors, it could also be applied to change the behaviors of healthcare providers. Incorporating this model into this clinical practice problem would allow the recognition and knowledge of the susceptibility of injury to the geriatric trauma population and establish preventative measures to reduce them. Employing the concept of HBM, if the staff on the trauma critical care unit was educated on the increased risk of complications in the geriatric trauma population with multiple rib fractures and on the evidence-based practices to reduce these complications, they would recognize their participation could positively affect patient outcomes.

Methods

The setting of the project took place on a Trauma Critical Care Unit in a large academic, urban, Level I Trauma Center. The rib fracture pathway included geriatric trauma patients, 65 years and older, with two or more rib fractures. Exclusion criteria consisted of patients under the age of 65 years and any patient at high risk for respiratory complications due to admitting injury (i.e., flail chest, severe pulmonary contusion(s), and open chest defect). No circumstances were found that raised ethical concerns and Institutional Review Board (IRB) approval was obtained.

The implementation team consisted of the current staff on the Trauma Critical Care Unit, which is included 57 nurses, two full-time advanced practice providers, six physicians, and four intensivists, as well as the Doctor of Nursing Practice Project Lead (DNP-PL), clinical site representative, and DNP faculty advisor. In the two weeks before the start of the project, staff voluntary completed an electronic survey of five Likert questions assessing baseline knowledge of the problem and current hospital practices and pathway competency on the Geriatric Rib Fracture Pathway. The primary components of the pathway included provider orders for deep breathe and cough, incentive spirometry use, and pain score assessments every four hours with subsequent completion of nursing implementation and documentation. The DNP-PL performed weekly chart audits to determine the compliance of the QI project by assessing rib fracture pathway initiation on eligible patients and nursing orders and documentation for pulmonary toileting and pain assessments within 24 hours of admission to the unit.

Implementation progress tracked the structural measure of staff education compliance of the pathway, process measures of staff compliance with the Geriatric Rib Fracture Pathway and implementation of the pathway on eligible patients, and outcomes measures of hospital-acquired pneumonia and unplanned intubations. Implementation strategies and tactics were largely impacted and modified throughout the implementation process due to the COVID-19 pandemic, staffing shortages, and high turnover of providers and nurses. The strategies and tactics consisted of collaboration efforts through provision of clinical supervision, obtainment of formal commitments, identification and preparation of champions, and incentivization with food; communication methods with frequent staff reminders, meetings to share project progress, and consistent education and training opportunities. Data was collected and collated weekly through chart auditing and analyzed with run chars. To protect patient information during the implementation, no patient identifiers were utilized in any of the data collection and extraction, random chart audits were deidentified of patient information, and access to the electronic health record (EHR) for audits was password protected and limited to authorized personnel. All collected data was securely stored in the charge nurse's locked office.

Results

Prior to the start of project implementation, comparative data on patients who met the inclusion criteria was obtained, staff competency training was performed, and a staff survey was distributed. Baseline data was collated from August 23 to September 19, 2020 on eligible patients (n=3). The data revealed shortfalls in nursing documentation every four hours of the evidence-based interventions deep breathe and cough and incentive spirometry with 0% compliances, variable compliance with pain assessment documentation every four hours from 0% to 100% (mean=83.3%), and 0% compliance of provider orders placed within 24 hours of patient admission. An anonymous electronic survey including four Likert-style questions was created to assess the staff's perception of the significance of the problem and current clinical practices and was voluntarily completed by the unit nurses and providers (23% response rate, n=14). A majority of the staff strongly agreed that geriatric trauma patients with rib fractures are at higher risk for complications compared to younger trauma counterparts (93%, n=13), strongly disagreed that the trauma critical care unit managed geriatric trauma patients with multiple rib fractures in a standardized process (93%, n=13), strongly agreed that geriatric trauma patients with multiple rib fractures are likely to have longer lengths of hospitalization (100%, n=14), and strongly agreed that a standardized pathway for the care of geriatric trauma patients with multiple rib fractures would improve outcomes (71%, n=10). From September 1 to 15, 2020, competency training was performed on the Geriatric Rib Fracture Pathway with 86% compliance by nursing staff (n=49) and 100% compliance by critical care providers (n=12).

Next, project implementation data was collected between September 20 to November 28, 2020. During an eight-week period, data was collected on seven patients that met the inclusion criteria for the Geriatric Rib Fracture Pathway. Of note, no data were obtained during weeks 8, 12, 13, and 14 due to an absence of patients who met the project's criteria. Run charts and descriptive statistics were employed to analyze project adherence during implementation (see Appendix G). Overall, staff compliance with the Geriatric Rib Fracture Pathway improved. There was an increase in weekly compliance of all components of the pathway – provider orders placed within 24 hours of patient admission ($p<.001$, range=50-100%, median=75% and mean=91.7%); deep breathe and cough nursing documentation every four hours($p<.001$, range=0-100%, median=14.3% and mean=63.5%); incentive spirometry nursing documentation every four hours ($p=0.006$, range=0-86%, median=0%, and mean=38.2%), and pain assessment nursing documentation every four hours ($p=0.068$, range=100%, median=100%, and mean=100%).

Discussion

Despite the vast research exposing the intensified consequences of rib fractures in the geriatric trauma population on morbidity and mortality, there was an evident gap in knowledge and in proven evidence-based practices to optimize clinical outcomes. Patient care pathways composed of evidence-based practices are commonly utilized to standardize patient care and improve quality and outcomes. Current literature findings widely support the use of evidence-based pathways within hospital systems as they uphold the best practices and systemize the clinical decision process (Chawla, Westrich, Matter, Kaltenboeck, & Dubois 2016).

Accordingly, rib fracture pathways for the geriatric population had concurrently exhibited benefits for improving patient outcomes. Multiple studies demonstrated that preemptive recognition and regulation of patients who had sustained multiple rib fractures resulted in decreased hospital length of stay (Sahr, Webb, Renner, Sokol, & Swegle, 2013), pain (Carrie et al., 2016), secondary respiratory complications, and mortality (Todd et al., 2006). This quality improvement project delivered initial support regarding the feasibility of implementing an evidence-based pathway for geriatric trauma patients admitted for multiple rib fractures based on previous studies after appropriate competency training in a trauma critical care unit.

Standardized approaches with the best evidence-based practices for geriatric patients with multiple rib fractures had been associated with reduced pulmonary complications and mortality as shown in studies conducted by Todd et al. (2006) and Kelley et al. (2019), improved pain outcomes by Carrie et al. (2016), and decreased length of hospitalization by Sahr et al. (2013). Although the purpose of this project did not explore the effects of an implemented pathway on patient outcomes, the findings supported hospital compliance with similar evidence-based interventions that would be suggestive of comparable results.

The variations in compliance with pathway components, except pain assessments, were likely due to staffing resources, a condensed implementation process, and differing prioritization of care needs. During the implementation of the project, hospital systems around the world were entangled in the devastation brought on by the COVID-19 pandemic. The pandemic caused significant changes in management, prioritization of care, and resource availability. Specifically, the unit experienced a considerable nursing retention issue, which forced administration to use supplemental staffing and as hire agency nurses.

Physician staffing was also affected due to a need for coverage in other critical areas, which created inconsistencies in provider care. The absence of reliable and veteran staff most likely had an enormous impact on the effectiveness of project implementation.

There were multiple limitations impacting the generalizability of the results. The findings of the project were established on an insignificant sample size of seven patients and no random sampling was performed. These factors influenced not only the generalizability of the results but also the reliability and validity. Despite data analysis showing statistical significance in pathway compliance, the limited sample size challenged the reliability and validity of these findings. Furthermore, the same patients were repeatedly used for clinical data that may have constructed both selection and design biases. Finally, the implementation of the project was performed during the height of the COVID-19 pandemic. Due to opposing resources and prioritization, commitment to the implementation of the Geriatric Rib Fracture Pathway was negatively affected.

Conclusion

This pilot QI project provided compelling support for establishing or expanding on an evidence-based pathway for geriatric trauma patients admitted for multiple rib fractures. Required competency with education of the problem and training on the pathway was essential for the success of efficient implementation. Staff competency training prior to the start of the project correlated with an increase in compliance with the Geriatric Rib Fracture Pathway.

Although buy-in from key stakeholders was imperative in achieving practice change, which was obtained, the sustainability of this project would also decidedly be dependent on the hospital's readiness to incorporate the practice based on resources and competing priorities. However, the Geriatric Rib Fracture Pathway proved to be a safe and strategic tool in proactive adoption of evidence-based interventions for a high-risk population that could improve clinical outcomes. Further research is recommended and should include a larger patient participation, a longer length of time for project implementation, and with possible future interventions targeted at evaluating the effects of the pathway on patient outcomes.

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Todd, S. R., McNally, M. M., Holcomb, J. B., Kozar, R. A., Kao, L. S., Gonzaolez, E. A., Brasseaux, B. K., & Moore, F. A. (2006). A multidisciplinary clinical pathway decreases rib fracture-associated infectious morbidity and mortality in high-risk trauma patients. *The American Journal of Surgery, 192*, 806 – 811. doi: 10.1016/j.amjsurg.2006.08.048

Table 1.

Literature Review

Citation: Butts, C. A., Brady III, J. J., Wilhelm, S., Castor, L., Sherwood, A., McCall, A., Patch, J., Jones, P., Cortes, V., & Ong, A. W. (2017). Do simple beside lung function tests predict morbidity after rib fractures?. *The American Journal of Surgery*, *213*(3), 473-477. https://doi.org/10.1016/j.amjsurg.2016.11.026					IV
Purpose/Hypothesis	Design	Sample	Intervention	Outcomes	Results
The purpose of this study was "to evaluate if incentive spirometry volume (ISV) and peak expiratory flow rate (PEFR) could predict respiratory failure in patients with rib fractures."	Prospective cohort study	**Sampling technique**: Convenience **Eligible participants**: Patients (18 years and older) with rib fracture(s) after blunt trauma who met requirement for inpatient admission, Glasgow Coma Scale Score (GCS) ≥14, were not expected to be intubated for the first 48 hours after admission, were deemed able to cooperate with lung function testing, and able to give consent. **Excluded**: Patients who required invasive or non-invasive mechanical ventilation, who were hypotensive (<100 mmHg), who had symptoms of shock in the emergency department, and where the time of injury exceeded 48 hours prior to presentation.	**Protocol**: Lung function testing was performed and recorded by a provider, and the best of three ISV and PEFR measurements were recorded. At three separate times (at admission, 24 hours, and 48 hours), ISV and PEFR were measured and recorded.	**Dependent variable(s)**: Acute respiratory failure (ARF) defined as "the need for invasive or non-invasive mechanical ventilation within 30 days after injury." **Measurement tool**: No specific tool or instrument was used for measuring the outcomes. Instead, the dependent variables were taken from data from the electronic health record.	**Statistical procedures**: Univariable analysis with chi-square tests, Fisher's exact test, and Mann Whitney *U* test **Results**: When ISV at admission is ≥1000 ml, there was a lower likelihood of ARF (I = 0.014). On the other hand, PEFR at admission and ISV and PEFR at 24 and 48 hours were not associated with ARF.

		Accepted: 99 **Power analysis**: None, increasing the risk of type II error **Group homogeneity**: Age ≥65 years and male gender were predominantly homogeneous, but there was heterogeneity in other characteristics such as history of pulmonary diseases and number of rib fractures, as displayed in Table 1.			
Citation: Carver, T. W., Milia, D. J., Somberg, C., Brasel, K., & Paul, J. (2015). Vital capacity helps predict pulmonary complications after rib fractures. *Journal of Trauma and Acute Care Surgery, 79*(3), 413-416. http://dx.doi.org.proxy-hs.researchport.umd.edu/10.1097/TA.0000000000000744					Level IV
Purpose/Hypothesis	Design	Sample	Intervention	Outcomes	Results
The purpose of this study was "to determine if vital capacity (VC) predicted complications and disposition in patients with rib fractures."	Retrospective chart review study	**Sampling technique**: Convenience **Eligible participants**: All patients admitted with rib fractures admitted between July 2009 and June 2012 **Excluded**: Patients who were pregnant, prisoners, and those who did not have a documented VC within the first 48 hours of hospital admission. **Accepted**: 683 patients **Power analysis**: None, increasing the risk of type II error **Group homogeneity**: Age ≥55 years and male gender were	**Protocol**: Predicted VC was determined from a gender-specific nomogram and used to standardize VC across patient groups. The best of three attempts is recorded as the patient's VC, and then the patient's daily VC was calculated by the average VC scores. The changes from daily VC scores and admission to discharge VC scores were documented in the electronic health record were noted.	**Dependent variable(s)**: Discharge to home versus extended care facility and pulmonary complications (defined as the development of pneumonia, intubation rate, transfer to the surgical intensive care unit for a respiratory issue, readmission for a pulmonary reason, and a new need for home oxygen) **Measurement tool**: Gender-specific nomogram used to standardize VC. Outcome measures were taken from the electronic health record.	**Statistical procedures**: Logistic regression model and odds ratio **Results**: Every ten percent increase in VC was associated with a decreased likelihood of discharge to an extended care facility ($p < 0.0001$) and decreased likelihood of pulmonary complication ($p < 0.0001$)

		predominantly homogeneous, but mechanism of injury was heterogenous, as displayed in Table 1.			
Citation: Chiumello, D., Coppola, S., Froio, S., Gregoretti, C., & Consonni, D. (2013). Noninvasive ventilation in chest trauma: systematic review and meta-analysis. *Intensive care medicine, 39*(7), 1171-1180. https://doi.org/10.1007/s00134-013-2901-4					Level I
Purpose/Hypothesis	Design	Sample	Intervention	Outcomes	Results
The purpose of this systematic review was "to critically review the literature to investigate whether noninvasive ventilation (NIV) reduces mortality, intubation rate, length of stay and complications in patients with chest trauma, compared to standard therapy."	Systematic review with meta-analysis	**Search strategy**: Computerized search of MEDLINE/PubMed and EMBASE of all literature from any date until July 2012 using keywords and terms "*chest trauma*," "*abdominal trauma*," "*pulmonary contusion*," "*posttraumatic hypoxemic respiratory failure*," "*trauma patients*," "*pneumothorax*," "*rib fractures*," "*noninvasive ventilation*," "*NIV*," "*continuous positive airway pressure*," or *CPAP*". Further literature search was done with the reference list of retrieved articles. This resulted in 263 articles and narrowed down based on the authors' exclusion and inclusion criteria. No blinding occurred during data collection, as authors are experts in	**Control**: In the RCTs, two studies' control groups consisted of continuous positive pressure ventilation and the other two used high flow oxygen therapy. **Intervention**: Interventions for all studies utilized NIV through a face mask delivered through noninvasive pressure support ventilation, bilevel positive airway pressure, or continuous positive airway pressure. **Protocol**: Not applicable	**Dependent variable(s)**: Mortality rate, intubation rate, complications, infection, hospital and ICU length of stay, gas exchanged defined as arterial oxygenation and arterial carbon dioxide content, and respiratory rate **Measurement tool**: No specified tool or instrument mentioned for measuring outcomes. Outcome measurement retrieved from data collection from electronic health record.	**Level of measurements**: Mortality, intubation rate, and complications were estimated using relative risk (RR) in patients treated with NIV compared with standard care. Length of stay, gas exchange, and respiratory rate were analyzed using weighted mean difference (WMD). **Analysis and Results**: Mortality (RR 0.26, p = 0.003), intubation rate (RR 0.32, p = 0.023), complications (RR 0.37, p < 0.001), and infections (RR 0.34, p < 0.001) were reduced in patients treated with NIV compared to standard care. ICU and hospital length of stay were decreased (p = 0.001, p = 0.162, respectively). Arterial oxygenation was higher (p = 0.029) and respiratory rate was

		their fields and were familiar with existing research and literature. Three reviewers screened selected titles and abstracts independently, and disagreement of any study was discussed as a group for unanimous approval. **Eligible studies**: Relevant randomized controlled trials (RCTs), prospective observational trials and retrospective observational studies that included adult participants with chest trauma who developed of mild to severe acute respiratory failure; admitted to a trauma service, emergency department, or intensive care unit (ICU); and treated with noninvasive ventilation (NIV). These studies had to list at least one of the following clinical outcomes: gas exchange, respiratory rate, hospital or ICU length of stay, complications, intubation rate, infections, and mortality.			lower ($p = 0.005$) in patients using NIV. **Conclusion**: Using NIV in adult patients with chest trauma may promote improved lung function and ultimately reduce mortality, hospitalization, intubations, complications, and infections, if utilized early in hospitalization. **Bias Risk**: Low potential based on systematic review methodology

		Excluded: 224 articles due to (1) unrelated to patient population, (2) irrelevance to systematic review, (3) abstract only, (4) study design not relevant, (5) spinal injury, and (6) unspecified trauma site. **Included**: Six observational studies and four RCTs (ten studies) with a total of 368 participants from various countries (Italy, United States, Spain, Greece, South Africa, Turkey, and Australia). **PRISMA**: Included in systematic review (Figure 1) that thoroughly depicted inclusion and exclusion of studies. **Power analysis**: Not applicable.			
Citation: Duggal, A., Perez, P., Golan, E., Tremblay, L., & Sinuff, T. (2013). Safety and efficacy of noninvasive ventilation in patients with blunt chest trauma: a systematic review. *Critical Care*, *17*(4), R142. https://doi.org/10.1186/cc12821					Level I
Purpose/Hypothesis	Design	Sample	Interventions	Outcomes	Results
The purpose of this systematic review was "to assess the current evidence regarding the use of NIV for patients with blunt thoracic trauma, to identify the most appropriate time to implement NIV and the safety of its use."	Systematic review conducted by a panel of authors who are experts in trauma and pulmonary injuries.	**Search strategy**: Computerized search of MEDLINE, EMBASE, and Cochrane Central Register of Controlled Trials (CENTRAL) databases using key terms "*NIV*" and "*blunt chest trauma*". Reference lists of retrieved studies as well	**Control**: Patients on high-flow oxygen (one study), patients mechanically ventilated (four studies), and no control group in four studies. **Intervention**: Interventions for all studies utilized NIV through a face mask	**Dependent variable(s)**: *Primary* – Duration of NIV *Secondary* – In-hospital mortality, ICU and hospital lengths of stay, development of nosocomial infections, and development of any barotrauma	**Level of measurements**: No statistical procedures were used in analyzing results of studies. Incident rates were performed on all clinical outcomes. **Analysis and Results**: Rates of mortality, ICU length of stay, and

		as studies from personal files were also included in the search. This resulted in 437 relevant studies, which were narrowed down based on the authors' exclusion and inclusion criteria. Two reviewers were responsible for going through the criteria for each study, and then all of the authors discussed whether the chosen articles were relevant to the purpose of their systematic review. **Eligible studies**: All studies that reported clinical outcome(s) in patients with blunt chest trauma that were managed with NIV. **Excluded**: (1) Study designs that were case reports, qualitative studies, and economic analyses; and (2) no clinical outcomes or interventions of interest **Included**: Three RCTs and six observational studies (nine total studies) **PRISMA**: Included in systematic review (Figure 1) that depicted inclusion and exclusion of studies.	delivered through noninvasive positive pressure ventilation or continuous positive airway pressure. **Protocol**: Not applicable.	**Measurement tool**: No specified tool or instrument mentioned for measuring outcomes. Outcome measurement retrieved from data collection from electronic health record.	nosocomial infections were higher in mechanically ventilated patients versus NIV patients. **Conclusion**: Using NIV in patients with chest trauma may promote lung function and ultimately reduce mortality, length of stay, and infections, if utilized early in hospitalization. **Bias Risk**: Moderate risk of bias based on lack of statistical analysis and subjective positive reporting of results.

		Power analysis: Not applicable			
Citation: Galvagno, S. M., Smith, C. E., Varon, A. J., Hasenboehler, E. A., Sultan, S., Shaefer, G., To, K. B., Fox, A. D., Alley, D. E. R., Ditillo, M., Joseph, B. A., Robinson, B. R. H., Haut, E. R., & Galvagno, S. M., Jr. (2016). Pain management for blunt thoracic trauma: A joint practice management guideline from the Eastern Association for the Surgery of Trauma and Trauma Anesthesiology Society. *Journal of Trauma & Acute Care Surgery*, *81*(5), 936–951. https://doi.org/10.1097/TA.0000000000001209					Level I
Purpose/Hypothesis	Design	Sample	Intervention	Outcomes	Results
The purpose of this systematic review was "to evaluate the optimal mode of analgesia for patients with blunt thoracic trauma."	Systematic review and meta-analysis of RCTs, case control studies, and prospective or retrospective observational cohorts conducted by a panel of authors who are experts in trauma and pulmonary injuries and are well-versed in the research.	**Search strategy**: Computerized search of PubMed, EMBASE, CINAHL, MEDLINE (OVID), and The Cochrane Register of Controlled Trials for studies published January 1967 to October 2015 using search terms "*epidural analgesia*," "*thoracic epidural analgesia*," "*blunt thoracic trauma*," "*thoracic injuries*," "*pneumothorax*," "*hemothorax*," "*rib fracture(s)*," "*sternal fracture*," "*chest contusion*," "*hospital mortality*," "*reintubation*," "*mortality*," "*pneumonia*," "*pulmonary atelectasis*," "*respiratory function tests*," "analgesia," "*patient-controlled analgesia*," and "*postoperative*	**Control**: Nonregional analgesics (i.e., oral, intravenous, patient-controlled), none, or placebo. **Intervention**: Regional analgesics (i.e., epidurals), multimodal analgesics, and intrapleural therapies. **Protocol**: Not applicable.	**Dependent variable(s)**: Pain scores; postoperative pulmonary complications defined as empyema, acute respiratory distress syndrome, pneumonia, and atelectasis; pulmonary function tests; need for mechanical ventilation; mortality; and hospital and ICU lengths of stay. **Measurement tool**: No specified tool or instrument mentioned for measuring outcomes. Outcome measurement retrieved from data collection from the electronic health record.	**Level of measurements:** Dichotomous outcome measures were calculated using relative risk with 95% confidence intervals (CIs) and continuous outcome measures were calculated by the mean difference with 95% CI analyzed using the Mantel-Haenszel random-effects model. **Analysis and results:** Patients with epidural regional analgesics were found to typically have less pain (p = 0.01), No statistically significant difference were found in postoperative complications between the two groups. Analysis of pulmonary function tests could not be reported due to heterogeneity of studies. Patients with regional analgesics had longer needs for

		pulmonary complications." The quality of evidence for each outcome was evaluated using the GRADE (grading of recommendations, assessment, development, and evaluation) framework. **Eligible studies**: RCTs, case-cohort studies, and prospective or retrospective observational cohort studies with a comparator group. **Excluded**: (1) No original data, (2) no comments, and (3) study design not relevant **Included**: Six RCTs and seven observational studies (total of thirteen studies) **PRISMA**: Included in systematic review (Figure 1) that thoroughly depicted inclusion and exclusion of studies. **Power analysis**: Not applicable			mechanical ventilation (OR 2.21). Although insignificant, patients with regional or multimodal analgesics were found to have decreased mortality rates and longer hospital length of stay but short ICU length of stay. Based on the GRADE framework, all outcomes had low quality and quantity of evidence. **Conclusion:** "In adult patients with blunt thoracic trauma, we conditionally recommend epidural analgesia over nonregional modalities of pain control (i.e., intravenous or enteral analgesics such as opioids, no statistically difacetaminophen, NSAIDs) for the treatment of pain. This recommendation is based on very low-quality evidence but places a high value on patient preferences for analgesia." **Bias risk**: Low bias risk based on methodology of systematic review. Risk

					of bias was assessed for each outcome using the Cochrane Collaboration and Jadad Scale.
Citation: Kelley, K. M., Burgess, J., Weireter, L., Novosel, T. J., Parks, K., Aesuga, M., & Collins, J. (2019). Early Use of a Chest Trauma Protocol in Elderly Patients with Rib Fractures Improves Pulmonary Outcomes. *The American Surgeon, 85*(3), 288 – 291. https://www-ingentaconnect-com.proxy-hs.researchport.umd.edu/content/sesc/tas/2019/00000085/00000003/art00034#					Level IV
Purpose/Hypothesis	Design	Sample	Intervention	Outcomes	Results
The authors hypothesized "that use of [chest trauma] protocol would decrease rates of unplanned intubations and transfer to the ICU."	Retrospective cohort study	**Sampling technique**: Convenience **Eligible participants**: Patients >45 years with two or more rib fractures after blunt trauma admitted to the step-down unit or the ICU **Excluded**: Patients with severe traumatic brain injury (GCS ≤ 8) or if they had a concomitant burn or had a length of stay <24 hours **Accepted**: 316 total participants **Control**: 176 **Intervention**: 140 **Power analysis**: None, increasing the risk of type II error **Group homogeneity**: The control and study group were heterogenous in Injury Severity Scores but homogeneous in age, abbreviated injury score thorax, and initial rate	**Control**: Pre-protocol **Intervention**: Post-protocol **Protocol**: Eligible participants are given patient-controlled analgesia pump combined with scheduled naproxen and acetaminophen, receive pulmonary toileting using incentive spirometry, and have application of NIV until discharge.	**Dependent variable(s)**: Rates of unplanned ICU admissions (defined as patients transferred to ICU after initial admission to the floor or step-down or the patients are transferred back to the ICU after being transferred out of the ICU), unplanned intubations (defined as intubation for cardiac or respiratory failure any time after initial evaluation or who are reintubated > 24 hours after extubation), and pneumonia (defined as bronchial lavage culture with >10^5 CFU of a single organism or chest X-ray findings of consolidation with an elevated white count >12,000 or fever over 101.5 degrees Fahrenheit that requires antibiotic treatment. **Measurement tool**: No instrument or tool	**Statistical procedures**: Continuous data was analyzed using the Student's *t* test and outcome measures were calculated using Fischer's exact test. **Results**: There was no statistical difference between the two groups in hospital and ICU lengths of stay or number of days on a ventilator. The intervention group had lower rates of unplanned ICU admissions ($p = 0.044$) and unplanned intubations ($p = 0.138$), no pneumonia ($p = 0.010$), and decreased mortality ($p = 0.120$).

		admission to ICU based on not significant and significant p values in Table 1.		mentioned for measuring outcomes. Outcome measurements retrieved from data collection from electronic health record.	
Citation: Rafiq, S., Steinbrüchel, D. A., Wanscher, M. J., Andersen, L. W., Navne, A., Lilleoer, N. B., & Olsen, P. S. (2014). Multimodal analgesia versus traditional opiate based analgesia after cardiac surgery, a randomized controlled trial. *Journal of Cardiothoracic Surgery*, *9*(1), 52–59. https://doi-org.proxy-hs.researchport.umd.edu/10.1186/1749-8090-9-52					Level II
Purpose/Hypothesis	Design	Sample	Intervention	Outcomes	Results
The purpose of this study was "to evaluate a multimodal analgesic regimen consisting of dexamethasone, gabapentin, ibuprofen and paracetamol against an opiate based regimen of morphine and paracetamol." The authors hypothesized "that the multimodal regimen had a better analgesic effect, reflected by an improved pain scoring, and a reduction of side-effects compared to the morphine group."	Prospective randomized controlled trial	**Sampling technique**: Convenience **Eligible participants**: Patients admitted to the institution between March 2007 and August 2009 who were age >18 years, had any cardiac procedure with sternotomy, and able to give informed consent. **Excluded**: Cardiac surgery without sternotomy, peripheral neuropathy, neurological disease, psychiatric illness, history of gastrointestinal bleeding chronic pain (back pain, cancer, arthritis), serum creatinine >150 μmol/L, hepatic disease with elevated liver enzymes, allergic to study medication, alcohol abuse, abuse of narcotics or medication, pregnancy,	**Control:** Participants were given morphine for analgesia. **Intervention**: Participants were given multi-modal pain therapy. **Intervention protocol**: Before extubation, ketorolac 30 mg, dexamethasone 8 mg and ondansetron administered together intravenously combined with paracetamol 1 g rectally. In the evening of postoperative day (POD) 0, paracetamol 1 g and laxative magnesium 1 g administered. POD 1 to POD 4, patients received the following oral analgesics: gabapentin 300 mg twice daily, ibuprofen 400 mg four times daily, paracetamol 1 g four times daily, pantoprazole 40 mg	**Dependent variable(s)**: *Primary* – evaluation of analgesic effect by 11-numeric rating scale *Secondary* – additional analgesic consumption, hospital length of stay (in days), evaluation of side-effects, cardiac complications (myocardial infarction, postoperative pericardial effusion, heart failure requiring inotropic support, or atrial fibrillation), other complications (stroke, bleeding, gastrointestinal bleeding, blood component requirements and sternal complications), and death from all causes **Measurement tool**: Daily questionnaire given to determine evaluation of side-effects of medications.	**Statistical procedures**: Categorical variables were analyzed using chi-square test or Fischer's exact test. Continuous variables were analyzed using the two sample *t*-test, Wilcoxon rank sum test, mean, and standard deviation. **Results**: Patients in the multimodal group had significantly lower average pain scores from the day of surgery to POD 3 (POD 0: p = 0.022, POD 1: p = 0.005, POD 2: p = 0.001, POD 3: p = 0.032) and suffered less in-hospital adverse events (p = 0.257).

		participation in other clinical trials, insufficient language skills, and ICU stay for more than 24 hours. **Accepted**: 180 were randomized into control or intervention group using sequentially numbered and sealed envelopes. Twenty-nine participants were eliminated after randomization due to prolonged ICU stay and withdrawal from trial, leaving a total of 159 subjects for analysis **Power analysis**: None, increasing the risk of type II error **Group homogeneity**: Intervention and group were considered homogeneous based on not significant *p* values displayed in Table 2.	once daily, and magnesium oxide 1 g once daily.	Other outcome measurement retrieved from data collection from the electronic health record.	
Citation: Sum, S. K., Peng, Y. C., Yin, S. Y., Huang, P. F., Wang, Y. C., Chen, T. P., Tung, H. H., & Yeh, C. H. (2019). Using an incentive spirometer reduces pulmonary complications in patients with traumatic rib fractures: a randomized controlled trial. *Trials, 20*(1), 1-8. https://doi.org/10.1186/s13063-019-3943-x					Level IV
Purpose/Hypothesis	Design	Sample	Intervention	Outcomes	Results
The purpose of this study was to explore "the effects of using an incentive spirometry (IS) on lung function and pulmonary complication rate in rib fracture patients."	Prospective, randomized controlled trial	**Sampling technique**: Convenience **Eligible participants**: Any adult (>18 years old) patient admitted between June 2014 and May 2017 with at least one rib fracture identified by chest X-	**Control:** Participants did not use IS **Intervention**: Participants were instructed to use IS **Intervention protocol**: All participants in intervention group were educated on use of IS in	**Dependent variable(s)**: *Primary* – Pulmonary complication rate defined as "atelectasis, pneumonia, hemothorax and, pneumothorax" *Secondary* – lung function tests	**Statistical procedures**: Independent *t*-test, chi-squared test, and a paired *t*-test **Results**: The intervention group had improvements in pre- and post-test %FVC ($p < 0.001$), $\%FEV_1$ ($p <$

		ray or computed tomography scan **Excluded**: Patients who are unconscious, have a history of COPD or asthma, or Injury Severity Scores (ISS) ≥16 **Accepted**: 50 participants randomly assigned into control or intervention groups by a sealed envelope **Control**: 26 **Intervention**: 24 **Power analysis**: 25 participants per group need to meet 80% significance at ∝ = 5% **Group homogeneity**: Intervention and group were considered homogeneous based on not significant *p* values in Table 1.	a sitting or semi-flower's position and instructed to use IS ten times per hour for a minimum of eight hours per day. Lung function was assessed by pulmonary function tests (PFTs) that were done on the 2nd (pre-test) and 7th (post-test) days of hospitalization by a pulmonologist.	measurements as defined as functional vital capacity (FVC) and forced expiratory volume in 1 second (FEV_1), length of hospital stay, and chest pain assessed using the numeric rating scale (NRS) **Measurement tool**: Authors do not mention tools utilized in outcome measurements. There is no mention on provider education of proper use of IS.	0.001); and lower pulmonary complications (25%) compared to the control group (75%) ($p <$ 0.001). There were no significant differences in length of stay and pain scores between the two groups.
Citation: Todd, S. R., McNally, M. M., Holcomb, J. B., Kozar, R. A., Kao, L. S., Gonzalez, E. A., Brasseaux, B. K., & Moore, F. A. (2006). A multidisciplinary clinical pathway decreases rib fracture-associated infectious morbidity and mortality in high-risk trauma patients. *The American Journal of Surgery, 192*, 806 – 811. https://doi.org/10.1016/j.amjsurg.2006.08.048					Level III *Landmark study
Purpose/Hypothesis	Design	Sample	Intervention	Outcomes	Results
The purpose of this study was "to evaluate the effect of this pathway on infectious morbidity and mortality." The authors hypothesized "that implementation would decrease infectious	Prospective observational cohort study	**Sampling technique**: Convenience **Eligible participants**: Trauma patients 65 years of age and older during the time period of January 1, 2007 to December 3, 2010	**Control group:** pre-pathway patients **Intervention group:** post-pathway patients **Intervention protocol**: All eligible participants were admitted to a monitored bed in the Surgical Intermediate	**Dependent variable(s)**: Mechanical ventilator-dependent days, ICU days, hospital days, pneumonia rate, and mortality rate **Measurement tool**: Data was obtained from the Trauma Registry,	**Statistical procedures**: Continuous data was analyzed using the Student *t*-test and Mann-Whitney *U* tests. Categorical data was analyzed using chi-square tests. Linear and logistic regression were

morbidity and mortality.”		**Excluded**: Patients with concurrent severe traumatic brain injury, defined as a Glasgow Coma Scale score ≤8 and an abnormal brain computed tomography scan **Accepted**: 300 total participants **Control**: 150 **Intervention**: 150 **Power analysis**: None, increasing the risk of type II error **Group homogeneity**: Age and number of rib fractures were generally homogenous across the participants, but type of injuries were heterogenous, as displayed by the *p* values in Table 1.	Care Unit or Shock Trauma ICU where they enrolled into the multidisciplinary rib fracture pathway. The pathway focused on interventions performed by respiratory therapy (volume expansion protocol), pain service (to maximize pain control), physical therapy (to maximize mobility), and nutrition services (to optimize nutrition). Patients must meet all three entrance criteria (tolerable pain, incentive spirometry goal, and strong cough) for three consecutive days to be removed from the multidisciplinary clinical pathway.	pharmacy database, infection control continuous quality improvement database, and electronic medical record.	used to determine intervention to outcome measures. Odds ratio and confidence intervals were calculated. **Results**: Patients in the post-pathway group had longer mechanical ventilator-dependent days and ICU days, insignificantly shorter hospital days, and significantly reduced rates of pneumonia and mortality ($p = 0.0003$ and $p = 0.004$, respectively).
Citation: Wei, S., Green, C., Truong, V. T. T., Howell, J., Ugarte, S. M., Albarado, R., Taub, E. A., Meyer, D. E., Adams, S. D., McNutt, M. K., Moore, L. J., Cotton, B. A., Kao, L. S., Wade, C. E., Holcomb, J. B., & Harvin, J. A. (2019). Implementation of a multi-modal pain regimen to decrease inpatient opioid exposure after injury. *The American Journal of Surgery*, *218*(6), 1122–1127. https://doi-org.proxy-hs.researchport.umd.edu/10.1016/j.amjsurg.2019.09.032					Level IV
Purpose/Hypothesis	Design	Sample	Intervention	Outcomes	Results
The purpose of this study was “to quantify the effect of the multi-modal pain regimen (MMPR) on in-patient opioid exposure, discharge opioid prescribing, and self-reported Numeric	Retrospective cohort study	**Sampling technique**: Convenience **Eligible participants**: Patients (≥16 years) at least one rib fracture who were admitted to the Level 1 trauma center from 2010 to 2017.	**Intervention protocol**: The MMPR consisted of the following scheduled and around the clock medications: acetaminophen (24 hours of intravenous acetaminophen followed by oral acetaminophen),	**Dependent variable(s)**: The amount of medications given (i.e., morphine milligram equivalents [MME] and patient-controlled analgesics), recorded adverse events (ileus, cardiac arrest, unplanned intubations,	**Statistical procedures**: Bayesian methods and mean and 95% CIs **Results**: No differences in ileus ($p = 0.5$), cardiac death ($p = 0.1$), or death (p <0.001) pre-MMPR and post MMPR. There was a decrease in unplanned

Rating Scale (NRS) pain scores." The authors hypothesized "that the MMPR would be associated with decreased inpatient oral morphine milligram equivalents (MME) per patient day, decreased opioid prescriptions at discharge, and similar NRS pain scores."		**Excluded**: None indicated. **Accepted**: 6933 **Power analysis**: None, increasing the risk of type II error **Group homogeneity**: Overall homogeneity in sex and ISS but heterogeneity in age, race/ethnicity and unit of admission, as displayed by *p* values in Table 1.	gabapentinoids (48 hours of pregabalin followed by gabapentin), non-steroidal anti-inflammatory drugs [NSAIDs] (48 hours of celecoxib followed by naproxen)], lidocaine patches, and tramadol. This regimen was supplemented with stronger opioids on an as needed basis.	unplanned ICU admissions, hospital-free days, ventilator-free day, ICU-free days, and death), numeric pain scores, and amount of prescribed opioids at discharge. **Measurement tool**: No specified tool or instrument mentioned for measuring outcomes. Outcome measurements retrieved from data collection from electronic health record.	intubations (p <0.001), median average pain scores (p <0.001), median total MME administration (p <0.001), use of patient-controlled analgesia (p <0.001), and opioids prescribed at discharge (p <0.001) from pre- and post-MMPR. There were increases in unplanned ICU admissions (p <0.001), hospital-free days (p = 0.002), and ventilator-free days (p = 0.04), and no changes in ICU-free days (p = 0.45).

Table 2.

Synthesis Table

Evidence Based Practice Question (PICO): In the Multi-Trauma Critical Care Unit, does the use of a multidisciplinary rib fracture protocol have lower incidences of respiratory complications in the elderly trauma population (age ≥65 years) with two or more rib fractures?			
Level of Evidence	Number of Studies	Summary of Findings	Overall Quality

I	3	Chiumello et al. (2013) and Duggal et al. (2013) conducted systematic reviews and meta-analysis to investigate whether noninvasive ventilation (NIV) had positive effects on clinical outcomes in adult patients with chest trauma. Both reviewed randomized controlled trials and observational studies and found that patients with NIV had reduced mortality, intubation rates, hospital and intensive care lengths of stay, complications, infections and better pulmonary function (i.e., arterial oxygenation and reduced respiratory rates). . Galvagno et al. (2019) conducted a systematic review and meta-analysis of current literature to find to assess the best modes of analgesia for patients with blunt thoracic trauma. The authors found that patients with blunt thoracic trauma have better clinical outcomes (i.e., pain scores, mortality hospital and ICU length of stay, postoperative pulmonary complications, need for mechanical ventilation, and pulmonary function tests) when epidural analgesics and multimodal analgesics (i.e., use of a combination of analgesics) compared to opioids alone In adult patients with blunt thoracic trauma, we conditionally recommend the use of epidural analgesia and multimodal analgesia (i.e., use of different classes of analgesics).	**C** Although both systematic reviews established a positive impact of NIV on patients with chest trauma, they both systematic reviews had several limitations that weakened their reliability and validity. The first was the characteristics of NIV (i.e., continuous positive airway pressure versus bilevel positive airway pressure) were heterogenous among the studies; however, the overall use of any method of NIV proved to be beneficial in this patient population. The measures and results were consistent between the two reviews. Secondly, both systematic reviews had limited number of studies and small sample sizes of each study limiting internal validity and generalizability. Duggel et al. (2013) recommended that future research through well-designed RCTs need to be done to further support the use of NIV in patients with chest trauma. **B** The overall study design and method were thoroughly constructed to increase validity and reliability of results. The authors decreased bias by implementing the use of the GRADE framework to assess evidence of the clinical outcomes of the studies. There were some limitations of the review. Many of the outcome measures had substantial heterogeneity in their protocols, trial populations, interventions, and outcomes, weakening internal and external validities. Most of the studies also had small sample sizes. Overall, the results were consistent, and recommendations were made for future research.
II	2	Sum et al. (2019) found that the use of incentive spirometry (IS) resulted in lower prevalence of pulmonary complications (atelectasis, pneumonia, hemothorax, and pneumothorax), improved pulmonary function, and decreased hospital length of stay in adult patients with rib fracture(s) compared to not using an IS. Rafiq et al. (2014) found that the use of multi-modal pain therapy versus only morphine analgesics had a significant	**C** The study was feasible with minimal barriers to implementation. Randomization of participants enhances internal validity. However, the sample size was small and based on power analysis, the study fell short of meeting sample size sufficiency in the intervention group by one participant, increasing type II error. Although the patients were randomly assigned, there was no blinding of intervention that could lead to user bias. The results were consistent and recommendations for further studies were clearly stated.

		decrease in average pain scores from postoperatively, as well as decreases in overall in-hospital adverse events such as cardiac, neurological, and gastrointestinal complications.	**C** Although the study design did have a comparator group increasing validity and reliability of the results, the authors do mention that further research should be completed with a placebo control group. Furthermore, while the effect and efficacy of each drug cannot be determined. the general combination of multimodal pain therapy has a positive compounding outcome to pain scores and in-hospital complications. The results and measures were consistent.
III	1	In their landmark study, Todd et al. (2006) found that a multidisciplinary clinical pathway that included interventions from respiratory therapy, nursing, providers, physical therapy, nutrition, and pain services significantly reduced pneumonia and mortality rates in older patients (age >45 years) with greater than four rib fractures. They incorporated an algorithm or pathway that enrolled eligible participants into this rib fracture protocol to enhance clinical outcomes. Three main criteria were assessed throughout the pathway – pain level, strength of cough, and incentive spirometry volumes.	**B** This was a feasible study with a small sample size. The study was thoroughly designed with specific roles for each support staff and had a clear and concise pathway for the eligible participants that providers could follow. The study lacks randomization and has varying threats and biases that weaken its validity and reliability. The results were consistent, but the authors lacked suggesting recommendations for future research.
IV	4	Butts et al. (2017) and Carver et al. (2015) found that vital capacity may have predictive value in determining outcomes with patients with fractured ribs. Higher vital capacity scores were associated with lower likelihood of pulmonary complications. Wei et al. (2019) found that implementation of a multi-modal pain regimen (MMPR) significantly reduced opioid exposure both inpatient and need at discharge. It also positively impacted numeric pain scale ratings and reduced unplanned intubations. Kelley et al. (2017) found that implementation of a chest trauma protocol significantly reduced unplanned ICU admissions and pneumonia rates. The study also showed decreased rates of	**C** Both studies found that higher vital capacity levels were more likely associated with decreased pulmonary complications such as atelectasis. Although the design of retrospective studies decreases internal validity, the results and measures were consistent in both studies and recommend further research to validate these results. **C** The study of MMPR showed improvements in pain scores and reduction opioid use. There were limitations in MMPR including determining the effectiveness of the individual medications included in the MMPR cannot be ascertained and generalizability of the medications based on population characteristics, formulary availabilities, and cost. Furthermore, generalizability is further reduced with the population trial that included verbalizing and alert patients. The results were consistent, and recommendations are made for further research. Lastly, the authors' address the positive cultural effects of implementation of this study on provider awareness of the opioid epidemic. **C** The study's findings showed there were significant decreases in pneumonia rates and unplanned ICU admissions

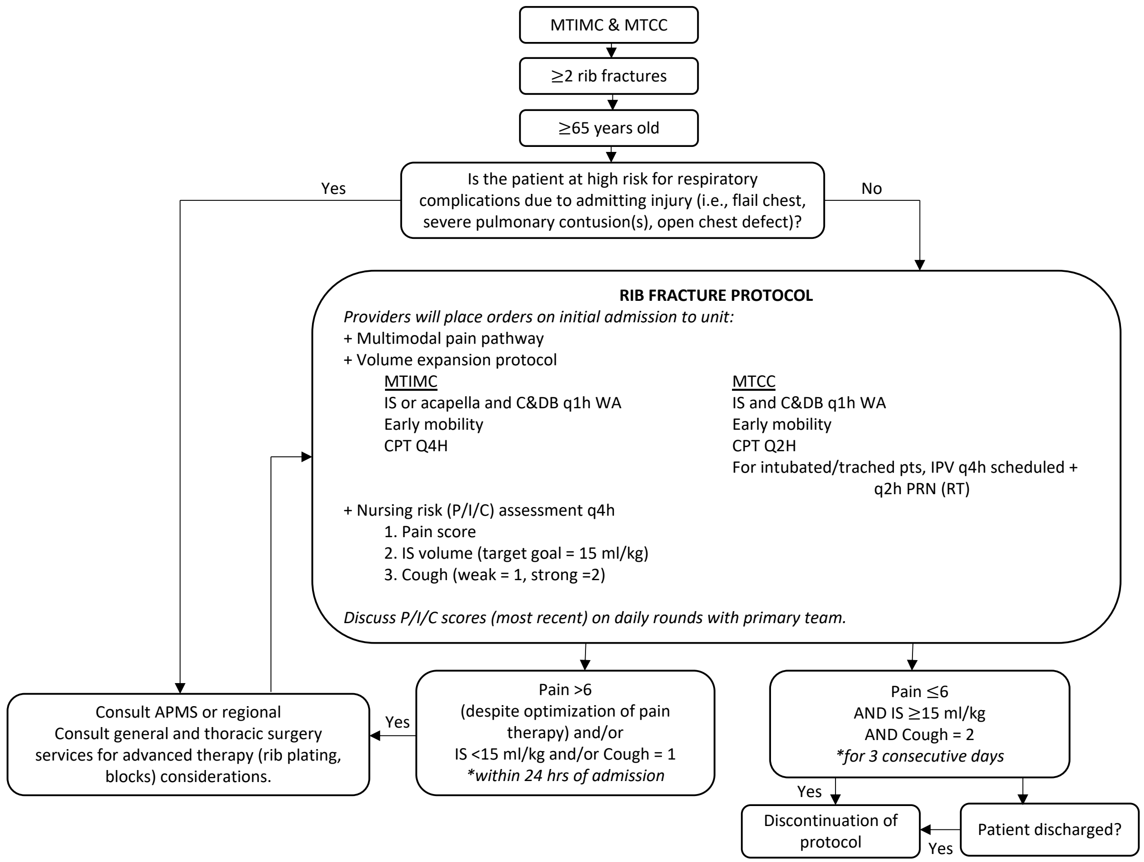
		unplanned intubations and mortality, although the findings were insignificant. The chest trauma protocol utilized an algorithm for providers to utilize for eligible patients with rib fractures to improve clinical outcomes. It incorporated a multidisciplinary approach to care with involvement from providers, respiratory therapy, and nursing.	when the chest trauma protocol was implemented. The study design (lack of randomization, user threats and biases), lack of power analysis of sample size, and overall population homogeneity weakens the validity and reliability of the results. The results are consistent with other literature noted in the article and recommendations for further research are made.

*Ratings based on The Johns Hopkins Nursing Evidence-Based Practice Rating Scale.

Newhouse, R., Dearholt, S., Poe, S., Pugh, L.C. & White, K. (2005). The Johns Hopkins Nursing Evidence-Based Practice Rating Scale. The Johns Hopkins Hospital, The Johns Hopkins University School of Nursing: Baltimore, MD

Appendix A

Multidisciplinary Rib Fracture Pathway for Geriatric Trauma Patients



Appendix B

Weekly Audit Tool for Compliance Rates of Usage of Pathway

Geriatric Rib Fracture Pathway Audit Tool (yes=1; no=2)						
Patient ID	**Date Audit Performed**	**Date of Admission**	**Rib Fracture Pathway Initiated**	**Pain Assessment Documented**	**Incentive Spirometry Use Documented**	**Cough and Deep Breathe Documented**

Appendix C

QI Project Outcomes Audit Tool

QI Project Outcomes Audit Tool		
	Pre QI Project	**Post QI Project**
Average Pain Scores		
Rate of hospital-acquired pneumonia		
Rate of unplanned intubations		

Appendix D

Staff Usability Survey

Usability Survey					
Question	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1. I believe the Geriatric Rib Fracture Pathway is easy to follow and use.					
2. The Geriatric Rib Fracture Pathway benefits the intended population.					
3. The Geriatric Rib Fracture Pathway should be utilized as a unit standard of care.					

Appendix E

Pre and Post Implementation Survey via SurveyMonkey

Pre and Post Implementation Survey					
Question	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1. I believe that geriatric trauma patients with rib fractures are more at risk for having complications as their younger trauma counterparts.					
2. The Trauma Critical Care Unit is doing an excellent job in the management of geriatric trauma patients with multiple rib fractures.					
3. Geriatric trauma patients with multiple fractures frequently have complications prolonging their critical care stay.					
4. I would be willing to utilize an evidence-based pathway in standardizing the care of geriatric trauma patients with multiple rib fractures.					
5. Having a written pathway would empower me to advocate for this vulnerable population.					

Appendix F

Materials for Project Education on Unit Bulletin Board in Staff Breakroom

Implementation of a Geriatric Rib Fracture Pathway on the Multitrauma Critical Care Unit

Janet Lee, BSN, RN

1

Introduction of Topics

- Background
- Purpose statement
- Short-term goals
- Literature review
- Theoretical framework
- Implementation plan
- Data collection
- Data analysis
- Human subjects' protection

2

Background & Significance

- Rib fractures in the geriatric trauma population:
  - Increasing prevalence
  - Increased vulnerability and risk due to age-related changes and comorbidities
- Leaders of Shock Trauma Center (STC) on Multitrauma Critical Care (MTCC) identified higher rates of complications in this population
  - Pain
  - Respiratory
  - Length of stay
  - Mortality
  - Cost

3

Purpose

- The purpose of this quality improvement (QI) project is to implement and evaluate the use of an evidence-based rib fracture pathway in the geriatric trauma population on MTCC.

4

Short-Term Goals

- By September 15, 2020, 100% of the nursing staff on MTCC will be trained will be trained on the guidelines of the STC Geriatric Rib Fracture Pathway in order to increase staff education and understanding of the management of this subpopulation and ultimately improve patient outcomes and reduce patient and unit-related costs.
- By September 15, 2020, 100% the critical care providers on MTCC will be trained on the guidelines of the STC Geriatric Rib Fracture Pathway in order to increase staff education and understanding of the management of this subpopulation and ultimately improve patient outcomes and reduce patient and unit-related costs.

5

Literature Review

- Multimodal pain regimen:
  - Reduced hospital length of stay
  - Reduced pain scores
  - Decreased opiate exposure
- Bundled approach to care with blunt chest injuries optimized patient outcomes

6

Theoretical Framework of the Health Belief Model

7

Implementation Plan: Project Type, Population, & Setting

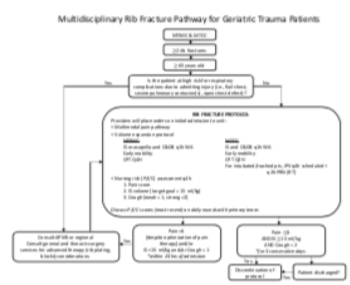
- Quality Improvement Project
- Population: Geriatric patients (≥65 years old) with ≥2 rib fractures
  - Exclusion criteria:
    - Trauma patients <65 years old
    - High risk of respiratory complications due to admitting injury
- Setting:
  - Trauma Intermediate Care & Intensive Care Unit in an academic Level I Trauma Center in an urban city

8

Implementation Plan: Structure & Process Changes

- Changes in structures
  - Staff education on target patients
  - Staff education on STC Geriatric Rib Fracture Pathway
- Changes in processes
  - Implementation of STC Geriatric Rib Fracture Pathway

9



10

Implementation Plan: Strategies, Tactics, & Timeline

11

Data Collection

- Tools:
  - Pre- and post implementation surveys using a Likert Scale via SurveyMonkey
  - STC Geriatric Rib Fracture Audit Tool
    - Weekly audits
  - Post-implementation usability survey using a Likert Scale via SurveyMonkey
  - QI Project Outcomes Audit Tool
- Data sharing via:
  - Weekly professional unit meetings
  - Conferences
  - Poster presentation

12

STC Geriatric Rib Fracture Pathway Audit Tool (yes=1; no=2)						
Patient ID	Date Audit Performed	Date of Admission	Rib Fracture Pathway Initiated	Pain Assessment Documented	Incentive Spirometry Use Documented	Cough and Deep Breathe Documented

QI Project Outcomes Audit Tool		
	Pre QI Project	Post QI Project
Average Pain Scores		
Rate of hospital-acquired pneumonia		
Rate of unplanned intubations		

13

14

Pre and Post Implementation Survey					
Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
(1) I believe that geriatric trauma patients with rib fractures are more at risk for having complications as their younger trauma counterparts.					
(2) The Multitrauma Critical Care Unit is doing an excellent job in the management of geriatric trauma patients with multiple rib fractures.					
(3) Geriatric trauma patients with multiple fractures frequently have complications prolonging their critical care stay.					
(4) I would be willing to utilize an evidence-based pathway in standardizing the care of geriatric trauma patients with multiple rib fractures.					
(5) Having a written pathway would empower me to advocate for this vulnerable population.					

Usability Survey					
Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
(1) I believe the STC Geriatric Rib Fracture Pathway is easy to follow and use.					
(2) The STC Geriatric Rib Fracture Pathway benefits the intended population.					
(3) The STC Geriatric Rib Fracture Pathway should be utilized as a unit standard of care.					

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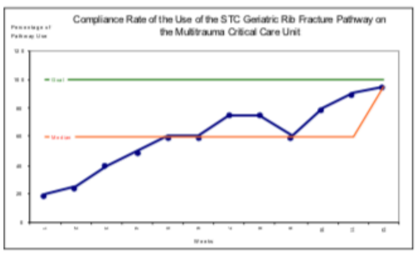
Statistical Analysis



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Protection of Human Subjects

- Proposal will be submitted to the University of Maryland Baltimore (UMB) Human Research Protection Office (HRPO) for a Non Human Subjects Research determination
- Proposal will be reviewed by faculty before submission
- Strategies to protect human subjects:
  - De-identified data collection
  - Anonymous surveys collected securely and electronically via SurveyMonkey
  - Data stored in charge nurses' locked office
  - Access to electronic health record is password protected

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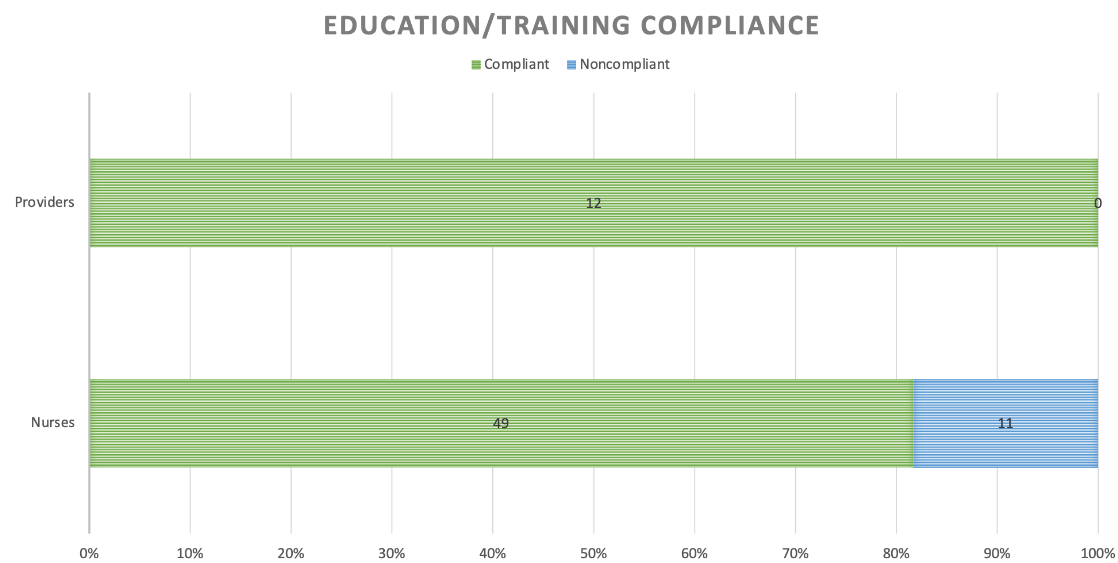
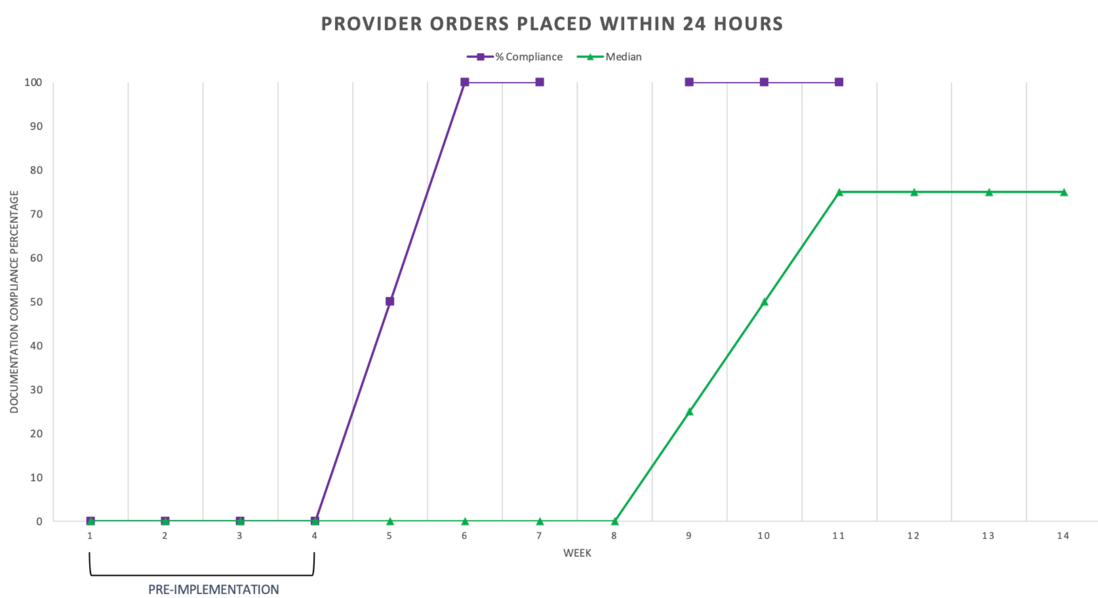
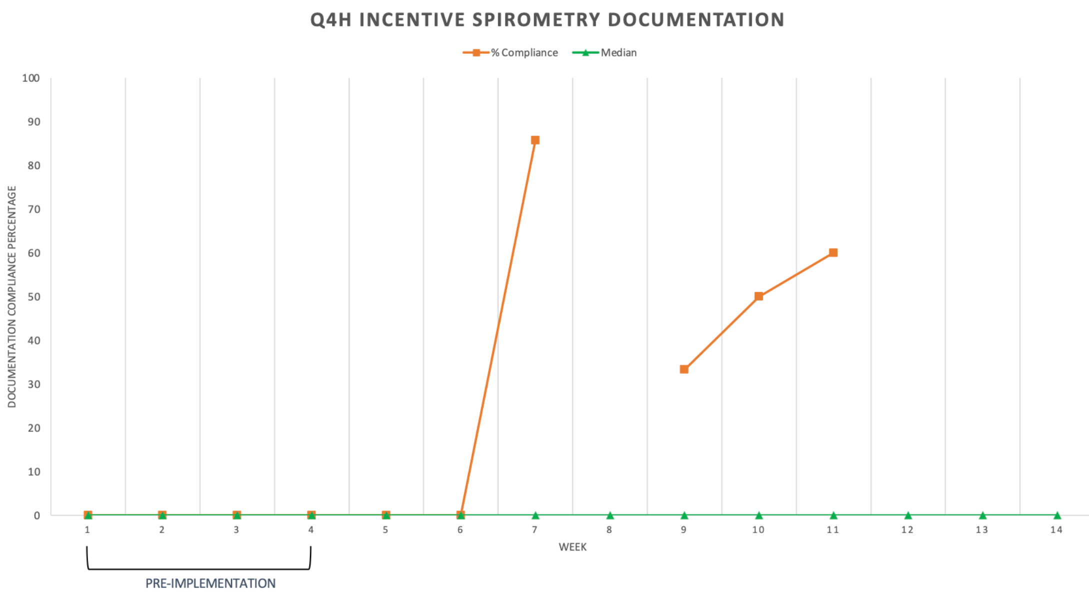
APPENDIX G

Figures Related to Project Results



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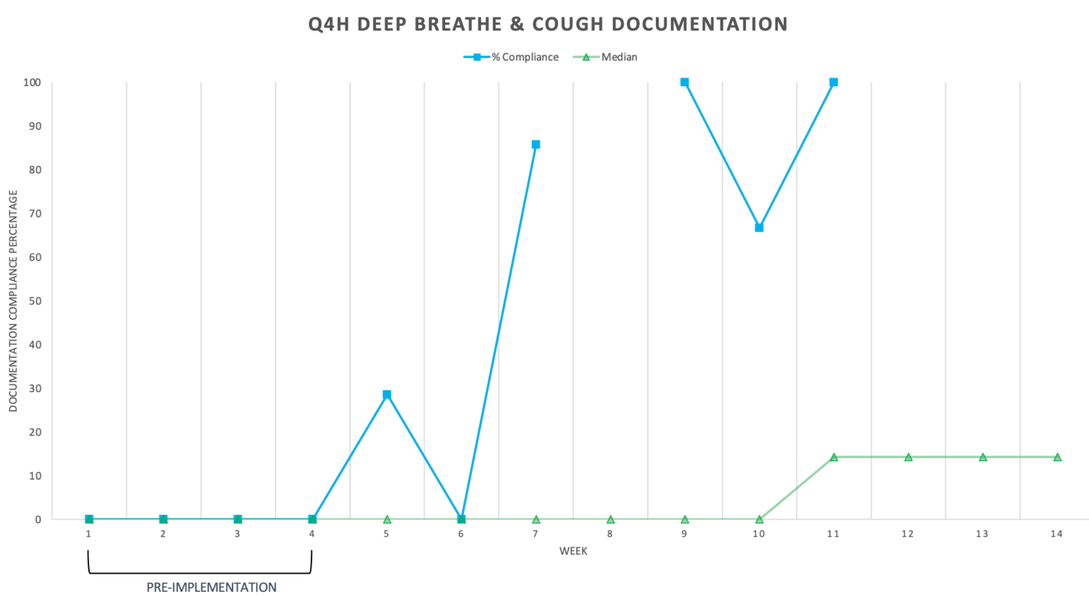
Median
DOCUMENTATION COMPLIANCE PERCENTAGE
WEEK
PRE-IMPLEMENTATION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% Compliance
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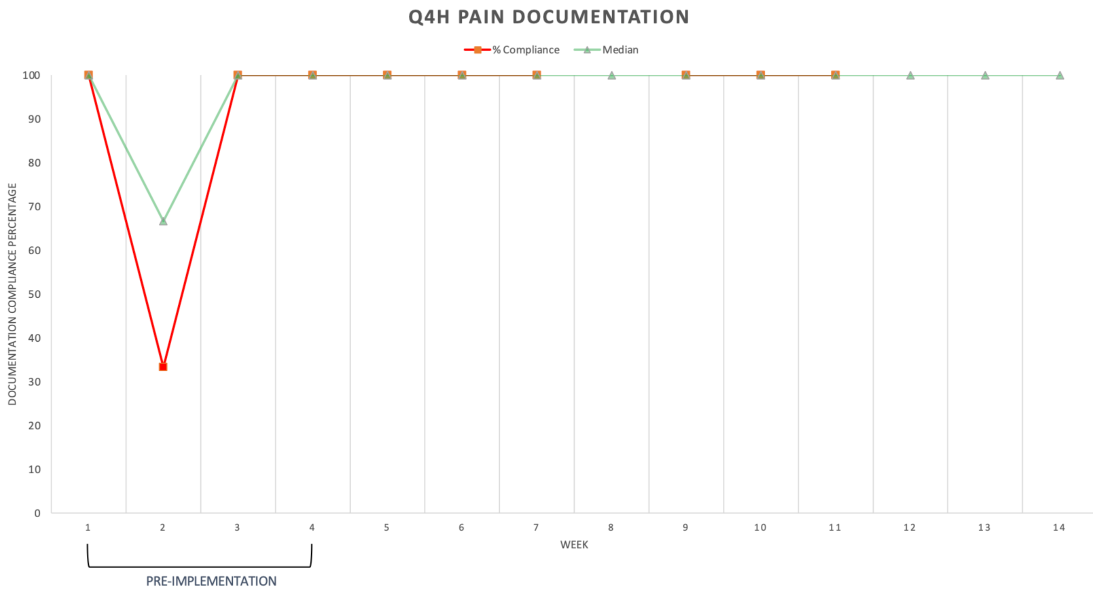
DOCUMENTATION COMPLIANCE PERCENTAGE
WEEK
PRE-IMPLEMENTATION


Q4H PAIN DOCUMENTATION
% Compliance
Median
DOCUMENTATION COMPLIANCE PERCENTAGE
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WEEK
PRE-IMPLEMENTATION