

Treatment of Elderly Patients Rib Fractures in the Acute Care Setting: An Integrative Review

A Scholarly Project

Submitted to the

Faculty of Liberty University

In partial fulfillment of

The requirements for the degree

Of Doctor of Nursing Practice

By

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Liberty University

Lynchburg, VA

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Abstract

This integrative review aimed to identify best practices associated with treatment for multiple rib fractures. The clinical question is, “In patients 60 and older with multiple rib fractures, are conservative treatments more effective in reducing comorbidities and mortality than surgical treatments?” This Integrative Review was conducted using Whitmore and Kanfl’ as a framework. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines were also used to conduct this review. Steps included problem identification, literature search with inclusion and exclusion criteria, data evaluation, data analysis through reduction and extraction, and presentation. This integrative review established that people over 65 experience longer hospital stays because they take more time to heal. In patients over 60 years, surgical treatment of multiple rib fractures could ease acute pain in the chest, lower the risks of other conditions (e.g., pneumonia), and reduce hospitalization compared to conservative treatment. Although surgical treatment was effective in treating patients with multiple rib fractures, this integrative review established that surgical treatment is costly and may increase the time patients spend in hospitals. The emergence of co-occurring injuries may limit the use of surgical treatment. Different complications, such as deep vein thrombosis and pulmonary embolisms, may occur after surgery. It is recommended that healthcare professionals increase the evaluation and screening of patients over 60 years old based on specific patient co-morbidities, demographics, and available screening tools for the best possible patient centered outcomes.

Keywords: conservative or surgical treatment, morbidity, mortality, rib fractures, older adult, surgical treatment, integrative review

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List of Abbreviations

Deep vein thrombosis (DVT)

Flail chest (FC)

Multiple rib fractures (MRFs)

National Council of State Boards of Nursing (NCSBN)

Patient-controlled intravenous analgesia (PCIA)

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

Treatment of Elderly Patients Rib Fractures in the Acute Care Setting: An Integrative Review

In trauma, rib fractures are quite common. Rib fractures influence the optimization of treatment regimens and the mortality and morbidity of multitrauma patients (Sawyer et al., 2022). Rib fractures cause reduced lung functional performance and carry a heavy disease burden (Gerakopoulos et al., 2019). Recent findings have revealed that despite the availability of nonoperative treatment of rib fractures, current optimized treatment involves surgical operations, also known as primary surgical fixations (Owattanapanich et al., 2022).

Much of the mortality and morbidity related to trauma admissions are a result of rib fractures. Ten percent of all trauma admissions are due to rib fractures, with mortality in multitrauma patients ranging from 10% to 30% (Gerakopoulos et al., 2019). Sawyer et al. (2022) reported concomitant injuries, pre-existing comorbidities, older age, and a higher number of rib fractures as risk factors for increased mortality and morbidity due to rib fractures. Additionally, Owattanapanich et al. (2022) reported pulmonary complications due to ineffective sequelae resulting in sepsis, ventilation-perfusion abnormality, and hypoxemia as the leading causes of mortality associated with rib fractures. Thus, identifying the specific impacts of rib fractures is challenging compared to other concomitant injuries.

The writer's interest in an optimized treatment regimen for rib fractures was influenced by increased morbidity and mortality and the burden of rib fracture-associated diseases. Xiao et al. (2020) revealed that management and treatment rib fractures are necessary to treat underlying thoracic injuries and restore pulmonary function to prevent complications. Y. Liu et al. (2018) noted that rib fractures have been treated with ventilator support, analgesia, and pulmonary hygiene. However, rib fracture stabilization has introduced a new management approach, as

surgical approaches are now employed to restore the chest walls' stability and mechanical integrity (Wijffels et al., 2019).

Previously, surgical fixation was used on patients with severe flail chest (FC) and for patients with whom conservative management had failed (Sawyer et al., 2022). In recent years, however, the application of surgical fixation in rib fracture treatment and management has expanded with positive outcomes demonstrated in the few completed observational and randomized controlled studies (Chen et al., 2022). Meta-analyses and systematic reviews have tried to justify surgical fixation over conservative management of rib fractures in patients with severe FC injuries (Liu et al., 2018). Several meta-analyses revealed that surgical rib fixations reduced patients' length of stay in hospitals and intensive care units, pulmonary complications, length of stay on ventilators, need for tracheostomy, and mortality (Owattanapanich et al., 2022; Wijffels et al., 2019).

Although numerous benefits for surgical rib fixation have been reported, the heterogeneity of the primary studies led to inconsistent findings reported among different meta-analyses (Xiao et al., 2020). The variability of fracture patterns negatively influences the ability to conduct a pooled analysis of individual studies, creates difficulty in scoring and diagnosing the severity of rib fractures and es patient comorbidity characteristics (Long et al., 2020). The difficulties in pooling the findings of current studies have limited the application of these studies in clinical practice (Owattanapanich et al., 2022). Despite the scarcity of literature on the subject, new treatment protocols are suitable cohorts for surgical rib fixation are being identified due to numerous associated benefits, such as shortened pain-endurance time and hospitalization time and the possibility of reduced complication incidence. Moreover, the lack of research has

negatively influenced decisions on the appropriate patient cohort for surgical fixations (Long et al., 2020).

Background

This integrative review investigated the morbidity and mortality outcomes of patients when a conservative or surgical mode of treatment was utilized, which had not been examined extensively in connection with treatment modality (e.g., Chen et al., 2022). The data were drawn from a collection of studies reporting empirical results on conservative or surgical modes of treatment and morbidity or mortality outcomes.

Factors potentially impacting morbidity and mortality were measured independently of whether a conservative or surgical treatment was used, such as the patient's Injury Severity Score, FC, and the number of rib fractures, which were examined widely throughout the extant literature (e.g., Hoepelman et al., 2022). In addition to concomitant conditions that might confuse the association between treatment and outcome, other demographics were used and believed to impact the association between conservative or surgical treatment and patient outcome. Factors influencing morbidity included gender, patient age, mean time from injury to admission, duration of pain experienced, and the number of daily self-care hours (e.g., Li et al., 2020).

Rib fractures are common in trauma and nontrauma health facilities, occurring in 10% to 36% of all blunt chest trauma patients admitted in different units (X. Liu & Xiong, 2019). Rib fractures account for 25% of all trauma-related deaths, making rib fractures the top cause of trauma-related deaths (X. Liu & Xiong, 2019). Xiao et al. (2020) stated that low-energy trauma in older adults triggered rib fractures. Having multiple or recurring rib fractures could negatively affect an individual's normal functioning. Studies have established that rib fractures could impair

chest functional performance and other health outcomes, negatively impacting an individual's normal life (X. Liu & Xiong, 2019).

Consequently, rib fracture remains a major health emergency with higher mortality rates. Most patients are likely to have more than one rib fracture, threatening their lives (Long et al., 2020). Most important is for health care practitioners to implement interventions designed to improve the well-being of all patients. Occasionally, failure to treat rib fractures in older adult patients could lead to death (Owattanapanich et al., 2022).

Different approaches exist for treating rib fractures: conservative and surgical methods. Although the adoption of surgical fixation for rib fracture treatment can be traced back to the early 1930s, physicians have used different methods to treat the rib fractures nonoperatively (Otaka et al., 2020). Rib fracture operations were considered risky; therapies and other conservative methods were preferred, especially in older adults with limited growth and development (Hoepelman et al., 2022). Examples of conservative or nonoperative interventions for rib fractures are pain management, mechanical ventilation (Otaka et al., 2020), inhalers, and physical exercise to improve pulmonary activities (X. Liu & Xiong, 2019). Although conservative methods have been widely used, there has been criticism from stakeholders and some physicians attributing the use of conservative rib fracture treatment to a 35% increase in mortality and rib fracture-related complications, including pulmonary congestion and pneumonia (Chen et al., 2022; X. Liu & Xiong, 2019). However, important to note is that the increase in rib fracture complications could be influenced by other demographic characteristics, such as age and frequency of rib fractures (Hoepelman et al., 2022; Rockne et al., 2021).

Researchers have reported a 29% increase in failure to return patients back to their normal respiratory patterns (Long et al., 2020). Thus, conservative methods continue to attract

criticism about the efficiency of the treatment of rib fracture-related complications.

Consequently, modern methods such as surgical fixation have been suggested (Tang et al., 2022). However, what remains to be understood is the extent to which statistical differences exist among mortality, morbidity, unit stay, and hospital length of stay in conservative and surgical fixation rib fracture treatment methods (Sborov et al., 2022). Patients experiencing rib fractures are vulnerable to complications such as extended hospital stay, increased morbidity, and high mortality rates. Given conflicting research on the extent to which differences in outcomes exist between surgical fixation and conservative therapies to treat rib fractures in patients, additional research is warranted (Rockne et al., 2021; Tang et al., 2022). Although surgical fixation for rib fracture treatment is considered expensive compared to conservative therapies, it is still not known if the cost of the surgical fixation approach minimizes rib fracture complications such as morbidity, mortality, and length of hospital stay (Sedaghat et al., 2021). In addition, it is still unknown which method is more cost-effective when treating rib fractures in the older adult population (Owattanapanich et al., 2022; Rockne et al., 2021).

Over the years, there has been an increase in interest in research related to rib fracture treatment methods (Sborov et al., 2022). However, there remains a practical gap in the literature regarding the extent to which differences exist in hospital length of stay, mortality, and morbidity in patients treated with conservative therapies and surgical fixation (Sedaghat et al., 2021). Therefore, this integrative review examined the efficacy of surgical fixation and conservative therapies on clinical outcomes, including hospital length of stay, morbidity, and mortality after undergoing rib fracture treatment.

Rationale for Conducting the Review

Multiple rib fractures (MRFs) occur in 10%–20% of adult high-energy trauma victims (Sborov et al., 2022). Due to the absence of rib support in the chest wall, MRFs are frequently accompanied by an FC (Sborov et al., 2022). A huge increase in mortality is caused by FC, which regularly results in inconsistent chest wall movement that can cause life-threatening complications such as acute respiratory distress syndrome and hemodynamic abnormalities (Owattanapanich et al., 2022). For MRFs, surgical stabilization of rib fractures is vital (Owattanapanich et al., 2022). A single center randomized controlled trial and another analogous study revealed that this operation can enable normal physiological respiratory mechanics, preserve chest wall adherence, and lower the hospital length of stay, period of mechanical ventilation, and impediment rate (Sborov et al., 2022).

Of all trauma victims, 10% to 39% have rib fractures (Owattanapanich et al., 2022). The symptoms do not affect daily actions; however, sporadically, breathing failure is caused by acute distress and chest malformation that limit thoracic movement. Moreover, there is a strong connection between fractures of the rib and numerous respiratory issues, such as pneumothorax, hemothorax, and pulmonary dysfunction. As a result, certain patients require mechanical ventilation. Most patients who need artificial breathing for rib fracture treatment receive nonoperative care, have sufficient pain management, and are released without significant complications. Although the effectiveness of surgical rib fixation is a point of contention, some patients still elect this method of treatment. A few medical professionals use a wait-and-see approach, delaying surgical rib fixation until nonoperative treatment fails (Owattanapanich et al., 2022).

One systematic review indicated that compared to nonoperative therapy, surgical rib fixation was related to a shorter duration of mechanical ventilation and decreased mortality rates, postadmission pneumonia, and tracheostomy. Small patient groups and a wide range of surgical rib fixation timing characterized the research analyzed (Owattanapanich et al., 2022). Early surgical rib fixation led to shorter hospital and intensive care unit stays than late surgical rib fixation, according to a prospective study on the timing of surgical rib fixation by Xiao et al. (2020). However, Owattanapanich et al. (2022) needed to account for the features of the patients sufficiently, and there might have been prejudice in the screening process.

Purpose and/or Review Question

There has been a trend toward operative procedures as the norm for treating MRFs. However, the evidence remains limited, and further studies are needed before determining which surgical procedures are the most effective (Beks et al., 2019). For this project, a systematic literature review was used, focusing on demographic factors that might impact morbidity and mortality outcomes independent of which treatment approach was taken. The goal was to illustrate the most relevant factors to consider when formulating a treatment plan. Hence, the project aimed to identify best practices and the association between treatment type, morbidity, and mortality. With this information, medical and health are the focus of this integrative review: In patients aged 60 and older with multiple rib fractures, are conservative treatments more effective in reducing comorbidities and mortality than surgical treatments?

Formulate Inclusion and Exclusion Criteria

PubMed/Medline, Embase, CENTRAL, and CINAHL were the databases - comparing conventional and surgical therapy for rib fractures in older adults. The title and abstract were independently examined for eligibility for inclusion in the review. Both observational research

and randomized clinical trials were considered for inclusion. None of the peer-reviewed articles were over 5 years old and were all written in English. The search terms used were *conservative treatment, surgical treatment, morbidity, mortality, rib fractures, older adult, and integrative review*.

Conceptual Framework

Whittemore and Knafl's (2005) constant comparison approach method required the project leader to conduct a detailed methodological evaluation of the selected primary literature. The first step of Whittemore and Knafl's approach is that the question to be answered has a broad purpose and that the review question be clearly stated. The second step is a comprehensive literature search approach to collect all the data. The third step should include a rigorous evaluation of all articles' relevance to the clinical research question. In this case, conclusions were drawn from the articles based on recurring themes or concepts in the findings. The fourth step is to evaluate and analyze all the articles through reduction, display, comparison, and categorization. Afterward, conclusions were drawn from the themes repeated across different articles. The empirical rationale for using this framework in this integrative review was to develop an in-depth understanding of the approach to treating rib fractures that produces best outcomes related to mortality, morbidity, and length of hospital stay, which is likely to provide clinicians with adequate information to improve rib fracture treatment and management.

Section Two: Comprehensive and Systematic Search

Search Organization and Reporting Strategies

The literature was peer-reviewed, comparing conventional and surgical therapy for rib fractures in older adults. Both observational research and randomized clinical trials were considered for inclusion. The current integrative literature search used the Preferred Reporting Items for

Systematic Reviews and Meta-Analysis (PRISMA) approach. PRISMA is a research tool for conducting quality improvement projects, especially meta-analyses, and systematic literature reviews. The PRISMA guidelines help researchers select articles through four steps, guaranteeing the study's feasibility.

The search flow diagram allows the reviewer to identify what literature is included and what literature is excluded using rationale for deleting an article. The articles go through the identification stage by using the databases mentioned above. The next step is the screening step that identifies duplicates and pulls articles that are assessed using the title, abstract and key words used. The next step is to look for full text articles that are assessed for eligibility. Finally, analysis and synthesis of the data is used to answer the review question.

Studies Selection and Quality Assessment

Sawyer et al. (2022) reported statistically insignificant differences between surgical fixation treatment and conservative methods for rib fracture on clinical outcomes such as mortality, length of hospital stays, and morbidity. Given the inconsistent results of previous researchers, the investigators recommended further research on the topic to validate their findings using a large, diverse sample. Y. Liu et al. (2018) found differences between mortality rate and hospital length of stay in patients with rib fractures depending on the type of treatment but used both adults and youth in their study. This limitation shows the need for further research among older adults to validate their findings. This study sought to address that gap in literature.

Section Three: Managing the Collected Data

Design

The PRISMA guidelines include a checklist, and a flow diagram was developed to decrease bias and provide transparency in the search. Whitemore and Knafl (2005) provide guidelines to order, code, and categorize data from multiple sources using different methods, perspectives, or designs (Toronto & Remington, 2020). An integrative literature review is used to synthesize existing literature on a given topic and provide a detailed understanding of the phenomenon being studied. Researchers use integrative literature to conduct comparisons of two different interventions or practices within the clinical setting. Consequently, an integrative literature design was used to compare clinical outcomes (mortality, morbidity, and length of hospital stay) when older adult patients were treated for rib fractures using surgical fixation and conservative methods. A useful review of the studies and the major themes are described in detail in Appendix C.

An integrative design is also aligned with evidence-based research, in which researchers are required to guarantee the rigor of the analysis (Whitemore & Knafl, 2005). The design involved the project leader conducting preliminary evaluation and synthesis of scientific evidence on the topic. The project leader evaluated every study for quality, bias, and relevance to the clinical research question to enhance the rigor of the review.

Sixty articles were selected that discussed 46 studies. Out of these articles, six studies were repeated in at least two meta-analyses. The final 15 articles had different research methods. Six research articles from randomized clinical trials, four systematic literature reviews, and one qualitative and one quantitative study were included in the review. The selected articles underscored the impacts of conservative treatment and surgical fixation rib fracture treatment

methods on mortality, morbidity, and length of hospital stay. The integrative review's target population was older adult patients with rib fractures.

Ethical Considerations

The project leader completed the Collaborating Institutional Training Initiative training requirements set by Liberty University guidelines. Although this integrative review project did not require human participants, the reviewer submitted the study proposal to Liberty University's Institutional Review Board, and the project was found to be exempt.

Data Collection

The integrative review used a stepwise approach to the literature search. Identifying the parameters guaranteed the rigor of the data collection and ensured the data collected supported the clinical question. The project leader used four electronic databases to identify articles that met the eligibility criteria. The population of focus for this integrative review was older adults aged 60 years or older. The search used “surgical treatment for rib fractures” as an “intervention.” “Conservative treatment for rib fractures” as the comparator, and the search domain used for “outcome measures” were morbidity and mortality. The search also utilized the following terms: *conservative treatment*, *surgical treatment*, *morbidity*, *mortality*, *rib fractures*, *older adult*, and *integrative review*.

Data Analysis

Data analysis was key in this integrative review as it provided insights into interest. Data analysis aimed to allow the project leader to present findings and the corresponding interpretations without bias. Researchers should also document the major findings based on the extracted data to strengthen the analysis process in support of rigor in the evaluation process.

In this project, data analysis was conducted using Whittemore and Knafl's (2005) five steps: problem identification, literature search with inclusion and exclusion criteria, data evaluation, data analysis through reduction and extraction, and presentation. The first step required the project leader to define the clinical question providing a justification of how it related to the project topic. Identifying the clinical question was important as it provided insights into how data could be obtained from different primary sources. Step 2 involved identification of all appropriate sources from the selected databases. The step also involved the use of keywords or terms to search the databases. In addition, the collected data from the primary articles were evaluated using different methods to guarantee authenticity. Next, the project leader analyzed and interpreted the findings based on the clinical questions. The last step entailed drawing conclusions based on collected and analyzed data. The results were displayed using tables.

Data Reduction

Data reduction was the first step in integrative literature review analysis. Data reduction required the project leader to arrange data as they were retrieved from primary sources. Organizing data and reducing that data to a manageable format provided the project leader an opportunity to evaluate the data and the extent to which they were verifiable. The project leader needed to ensure that all relevant articles were organized and grouped.

Data reduction included grouping articles based on topic, intervention, publication year, setting, research methodology, and significance. After identifying articles, the project leader organized data to guarantee its accessibility for further analysis. Another key step in the data analysis was the comparison of data. When comparing data, the project leader must critically assess data types, patterns, repetitive phrases, similarities, and relationships. A comparison should be made between the primary articles.

Data comparison was important in the integrative literature review process as it permitted the project leader to provide a detailed understanding of how data relate to each other. This process allowed the project leader to assess the similarities or differences in clinical outcomes (mortality, morbidity, and length of hospital stay) when surgical fixation or conservative treatment was utilized. The last step in the data analysis was to draw conclusions from the data and verify the findings. In this case, the project leader drew conclusions based on the analysis conducted in the primary sources. The project leader reviewed every finding reported to provide insights into how mortality, morbidity, and length of hospital stay differed when conservative rib fracture methods and surgical fixation were used. This process allowed the project leader to draw conclusions based on the findings and offer recommendations.

Section Four: Quality Appraisal

Data analysis is a difficult step in the integrative review process since it requires the reviewer to combine data from multiple methodological sources (Toronto & Remington, 2020). Even though methods for analyzing and synthesizing data for integrative reviews continue to improve, adherence to systematic procedures at this point is crucial for limiting bias. Using rigorous and transparent data analysis techniques promotes a confidently implementable evidence synthesis (Toronto & Remington, 2020).

This section discusses the methods of quality appraisal of articles in this integrative review. This section includes information about sources of bias, the integrative review's internal validity, the appraisal tools used, the applicability of the integrative review results, and the reporting guidelines followed. Fifteen articles were included in this review (see Appendix B). These articles were coded by the study method and its purpose. The themes were further broken down by conservative versus rib fracture fixation. The Injury Severity Score, surgical timing,

age, rib fracture patterns, delirium, and analgesia strategies are just a few themes extrapolated from the articles. Appendix A depicts the process by which these articles were selected.

Sources of Bias

Systematic literature reviews aim to minimize bias by following a rigorous and standardized process (Hughes-Morley et al., 2015). However, bias can still arise at various stages of the review process. Publication bias, selection bias, and reporting bias are common types of bias in systematic literature reviews. Publication bias is a type of bias that occurs when studies with significant or positive results are more likely to be published in scientific journals. In contrast, studies with nonsignificant or negative results are less likely to be published. This bias can impact the results of a systematic review, as the review's findings are based on the studies that have been published and included in the analysis (Hughes-Morley et al., 2015). Publication bias was minimized in this integrative review using comprehensive search strategies that did not unnecessarily limit the studies included in this review. This process allowed for a broader range of studies to be included, thus limiting publication bias in one subset of the literature.

Selection bias occurs in systematic literature reviews when the selection of studies to include in the review is not conducted unbiasedly (Hughes-Morley et al., 2015). It occurs when the characteristics of the studies included in the review are systematically different from those of the excluded studies, leading to biased estimates of the effect size (Hughes-Morley et al., 2015). The project leader developed clear and unbiased inclusion and exclusion criteria for this integrative review to minimize the chance of selection bias. As mentioned, a comprehensive search strategy was used to identify all relevant studies.

Reporting bias can occur in systematic literature reviews when there is a discrepancy between what is reported in the published literature and the full data set available (Hughes-

Morley et al., 2015). This issue can arise due to selective reporting of results, where only certain outcomes or findings are reported, and others are omitted. Reporting bias can occur during the study's design, the data analysis, and the reporting of the results. It can be intentional or unintentional and can arise for assorted reasons, such as pressure to produce positive results, publication bias, and conflicts of interest (Hughes-Morley et al., 2015). The comprehensive search strategy used in this integrative review limited reporting bias. This search strategy did not limit the included studies by methodology or design. This strategy ensured that a wide variety of data was reported and included in this integrative review. The risk of bias in the studies was also assessed for each article included in this review. The project leader considered any discrepancies between the published results and the available data set.

Internal Validity

Internal validity is the degree to which the results of a study accurately reflect the true effect of the intervention or exposure being studied (Higgins & Green, 2011). Regarding systematic reviews, internal validity refers to the degree to which the findings accurately reflect the true result of the studies included without being impacted by selection bias or reporting bias (Higgins & Green, 2011). The careful avoidance of those types of bias increased the internal validity of this integrative literature review. The project leader adhered to Whittemore and Knafel's (2005) reporting guidelines for integrative reviews to increase internal validity further. Furthermore, this process increased the replicability of the study results by establishing a straightforward way to confirm the findings of this integrative review.

Appraisal Tools

Levels of evidence were applied to this integrative review using Melnyk's hierarchy of evidence (Melnyk & Fineout-Overholt, 2011). Melnyk's levels of evidence are endorsed by the

National Council of State Boards of Nursing (NCSBN, 2011), whose toolkit recommends the use of the levels of evidence in all nursing research. NCSBN urges nurses to think of the hierarchy of evidence as a pyramid, with the top being the strongest type of study and the bottom of the pyramid representing the weakest evidence. Melnyk's hierarchy of evidence is a system often used for assigning levels of evidence in nursing by integrating clinical expertise and patient choices with the best available research. The benefits of using this system include that it assists the researcher in:

- identifying the best available evidence for clinical decision-making,
- evaluating the quality of evidence,
- determining the strength of recommendations, and
- identifying gaps in knowledge and areas for future research.

Melnyk's levels of evidence are as follows:

- Level I: Systematic reviews
- Level II: Critically appraised topics (evidence synthesis)
- Level III: Critically appraised individual articles (article synopsis)
- Level IV: Randomized control trials
- Level V: Cohort studies
- Level VI: Case controlled studies/case series/reports
- Level VII: Background information/expert opinions

Polit and Beck (2012) suggested researchers evaluate each article's measurement, attrition rate, validity, bias, interventions, statistical analysis, and discussion when selecting the

literature for the review. The primary appraisal tool used in this integrative review was Melnyk's levels of evidence (See Appendix B).

Applicability of Results

Toronto and Remington (2020) argued that the applicability of results in systematic literature reviews is an important consideration when interpreting and using the findings of such reviews. Although systematic reviews are considered the gold standard for synthesizing the findings of multiple studies, the applicability of these findings to real-world contexts can be limited. When considering the applicability of the results of a systematic review, Toronto, and Remington (2020) proposed a framework that consisted of the following domains: patient population, intervention or exposure, comparator, and outcome measures. Table 2 below presents these domains as they apply to this integrative review.

Table 2

Applicability of Integrative Review Results Domains

Domain	This integrative review
Patient population	Adults aged 60 years or older
Intervention or exposure	Surgical treatment for rib fractures
Comparator	Conservative treatment for rib fractures
Outcome measures	Morbidity and mortality outcomes

The purpose of this integrative review was to identify what various empirical results suggested in terms of the extent to which various demographic factors might confound the association between treatment type for rib fractures, morbidity, and mortality. Thus, the medical and healthcare care industries could be more aware of what factors to focus on when designing treatment regimens for older adult patients. The project leader selected studies for inclusion that were closely aligned with the domains above to ensure the results of this integrative review applied to the real-world medical and healthcare care industries.

Reporting Guidelines

This integrative review leveraged Whittemore and Knafl's (2005) reporting guidelines for integrative reviews. Whittemore and Knafl's integrative review methodology is a rigorous and systematic approach to synthesizing the findings of multiple studies on a particular topic. The approach combines elements of traditional narrative reviews and meta-analyses to provide a comprehensive and nuanced understanding of the existing literature. This methodology consists of five main steps: problem identification, literature search, data evaluation, data analysis, and presentation of the findings (Whittemore & Knafl, 2005).

Using Whittemore and Knafl's (2005) system, the first step in conducting this integrative review was to identify a clinical question or problem to guide the review. The second step was to conduct a comprehensive literature search using a combination of electronic databases and manual searches of reference lists. As recommended by Whittemore and Knafl (2005), the search was not limited by study design, and both qualitative and quantitative studies were included. Next, the data from the included studies were evaluated for quality and relevance. In this integrative review, Melnyk's hierarchy of evidence was used for assigning levels of evidence. It is represented by a pyramid that details the evidence's strength levels from 1 to 7, of which Level I is the highest. The benefits of using this system include that it assists the researcher in identifying the best available evidence for clinical decision-making, evaluating the quality of evidence, determining the strength of recommendations, and identifying gaps in knowledge and areas for future research. Finally, the findings of this integrative review are presented in a way that highlights the key themes and subthemes that emerged from the analysis.

Section Five: Data Analysis and Synthesis

With this information, the medical and healthcare industries could be more aware of what factors to focus on when designing treatment regimens for older adult patients. The results of the data analysis are discussed in this section. This section includes a presentation of descriptive results and the steps of data analysis used in this integrative review. A synthesis of research findings is presented. The section ends with a discussion of the ethical considerations of this integrative review.

Data Analysis

In this project, data analysis was conducted according to the five steps outlined by Whitemore and Knafl (2005): issue identification, literature search based on inclusion and exclusion criteria, data assessment, data analysis through reduction and extraction, and presentation. The first stage in data analysis was for the project leader to describe the clinical issue and connect it with the project topic. The second step entailed finding all relevant sources from the specified databases. The data were then analyzed and interpreted based on the clinical question. Braun and Clarke's (2006) thematic analysis process guided this interpretation process.

Braun and Clarke's (2006) thematic analysis process are a widely used qualitative research method for systematically and rigorously analyzing data. The process consists of six main phases. The first step in the thematic analysis process is familiarizing oneself with the data. This process involved reading and re-reading the data (i.e., the studies included in the review) to understand the overall content and identify preliminary themes. In the second step, initial codes are generated by identifying and labeling the data's most significant and relevant parts. These descriptive codes were generated through line-by-line coding, in which each relevant line of the data is assigned one or more codes. In the third step, the initial codes are examined and sorted

into potential themes. This process involved grouping similar codes and identifying patterns and connections between them. Themes were broader than codes and represented a meaningful pattern within the data. In the fourth step, the themes are reviewed and refined. This process involved checking whether the themes accurately reflected the data and whether they were meaningful to this study. The initial themes were revised or combined at this stage to create a final set. In the fifth step, the final themes are defined and named. This process involved creating a concise definition for each theme and selecting a name that accurately captured its essence. Finally, the analysis was written up. This process involved describing the themes and providing examples from the data to illustrate them in the data below.

Descriptive Results

The themes identified during data analysis related to the clinical question are discussed in this section.

Demographic Risk Factors

The studies included in this integrative review identified several demographic factors associated with morbidity and mortality among older adult rib fracture patients when adjusted for covariates. The most prevalent risk factors identified were age, injury severity, number of rib fractures, and comorbidities. These and other less prevalent risk factors are identified in Table 3.

Table 3*Demographic Factors That Impact Morbidity and Mortality Outcomes*

Risk factor	Number of studies	Studies
Age	7	Coary et al., 2020; Ho et al., 2020; Janssen et al., 2019; Peek et al., 2022; Peek et al., 2020; Prins, Wijffels, Wooldrik, et al., 2021; Vledder et al., 2019
Injury severity	7	Bass et al., 2023; Chen et al., 2022; Ho et al., 2020; Peek et al., 2022; Peek et al., 2020; Prins, Wijffels, Wooldrik, et al., 2021; Vledder et al., 2019
Number of rib fractures	6	Chen et al., 2022; Coary et al., 2020; Ho et al., 2020; Martin et al., 2019; Peek et al., 2022; Vledder et al., 2019
Comorbidities (heart disease, COPD, liver cirrhosis, metastatic cancer)	5	Bass et al., 2023; Ho et al., 2020; Janssen et al., 2019; Peek et al., 2022; Vledder et al., 2019
Placement of rib fractures	2	Coary et al., 2020, Chen et al., 2022
Disuse of epidural analgesia	2	Martin et al., 2019; Peek et al., 2022
Delirium	2	Bass et al., 2023; Janssen et al., 2019
Health behaviors (smoking, drinking)	2	Bass et al., 2023; Peek et al., 2022
Malnutrition	1	Janssen et al., 2019
Physical impairment	1	Janssen et al., 2019
Absence of noninvasive ventilation	1	Kelley et al., 2019

Note. COPD = chronic obstructive pulmonary disease.

Seven of the 15 studies identified age as a factor that increased the likelihood of morbidity and mortality related to rib fractures among older adult patients. In all seven of these studies, patients with more advanced age were at greater risk for experiencing negative outcomes after being treated at the hospital for fractured ribs. However, age was not uniformly found as a risk factor. Among the older adult population, Chen et al. (2022) found no increased risk of morbidity as age advanced: “Age (OR 0.99, 95% CI 0.25–3.33, $p = 0.988$) did not increase the risk of postoperative complications” (p. 5).

Injury severity was an equally prevalent characteristic that impacted an older adult's likelihood of experiencing morbidity or mortality. For example, Peek et al. (2022) stated, "Although flail chest was present in only 3.9% of the patients, it should be considered as a different entity due to the high mortality rate and prolonged hospital length of stay" (p. 269).

Six of the 16 studies cited the number of rib fractures as a significant factor impacting morbidity and mortality. Vledder et al. (2019) reported that patients with multiple risk factors experienced 2.6 times the risk of morbidity compared to patients with a single rib fracture. Coary et al. (2020) stated,

The absolute number of rib fractures sustained correlates with both morbidity and mortality. One study has reported mortality rates of 5.8% for patients' suffering a single rib fracture, rising to 34% for those with eight or more fractures. Increasing numbers of rib fractures are also associated with higher rates of pneumonia, aspiration, pneumothorax, and length of stay. (p. 162)

The presence of comorbidities was the final demographic characteristic that studies commonly found to increase the risk of morbidity and mortality among older adult rib fracture patients. Five of the 15 studies reported that comorbidities increased morbidity and mortality. Comorbidities included heart disease, chronic obstructive pulmonary disease, liver cirrhosis, and metastatic cancer. Vledder et al. (2019) reported increased morbidity and mortality related to co-occurring abdominal injuries (odds ratio: 6.8), spinal injuries (odds ratio: 4.6) and head injuries (odds ratio: 3.5). Vledder et al. also reported that chronic conditions carried less risk than acute injuries; however, the increased risk of morbidity remained significant. Specifically, chronic obstructive pulmonary disease (odds ratio: 1.3) and cardiac disease (odds ratio: 2.6) were associated with increased morbidity and mortality.

Impact of Treatment Type

The demographic characteristics that impacted outcomes were discussed in the literature. Themes related to conservative and surgical treatment outcomes were also identified through data analysis. These themes included improved outcomes with surgical treatment for rib fractures and increased hospital length of stay with surgical treatment for rib fractures, among less prevalent themes (see Table 4 below).

Table 4

Themes Related to Treatment Type for Rib Fractures and Morbidity and Mortality

Theme	Number of studies	Studies
Improved outcomes with surgical treatment for rib fractures	4	Coary et al., 2020; Ferrari et al., 2022; Hoepelman et al., 2022; Prins, Wijffels, & Pieracci, 2021
Increased hospital stays with surgical treatment for rib fractures	3	Ferrari et al., 2022; Hoepelman et al., 2022; Zhang et al., 2023
Presence of co-occurring injuries and conditions limited surgical fixation option	2	Coary et al., 2020; Vledder et al., 2019
No difference between surgical and conservative outcomes	2	Prins, Wijffels, & Pieracci, 2021 (if surgery performed late); Zhang et al., 2023

Four of the 15 studies found improved outcomes related to surgical treatment of rib fractures compared to conservative treatment. Ferrari et al. (2022) reported, “The mortality rate, considered the primary outcome, was higher in the conservative-treated group than the operatively treated patients (8.3% vs. 3%)” (p. 1). Hoepelman et al. (2022) stated, “Mortality was lower in operatively treated patients compared to conservative treatment (4% vs. 8%)” (p. 887). Although Coary et al. (2020) found no difference in mortality rates between the two treatment types, the authors reported that the surgical option was associated with a lower risk of other complications, such as pneumonia. Coary et al. (2020) said,

Several indications have been proposed for considering surgical rib fracture repair; these include flail chest, severe pain, and chest wall deformity. The most researched of these indications is flail chest. A recent meta-analysis evaluated the effectiveness and safety of surgical fixation in patients with flail chest, compared to conservative management [42]. Three studies including 123 subjects found no statistical significant difference in the primary outcome of death between the groups. However, in the surgical group, pneumonia, chest deformity and tracheostomy were reduced. (p. 165)

Although several studies found evidence that surgical treatment of rib fractures improved outcomes, studies also found that the surgical option increased the time spent in the hospital. These studies reported an increased cost associated with the surgical option and longer time spent in inpatient treatment. Zhang et al. (2023) said, “The length of hospital stay in the surgery group was significantly longer than that in the conservative group ($P = 0.000$)” (p. 1). Ferrari et al. (2022) reported comparable results: “Considering the secondary outcomes investigated, the overall intensive care unit stay, and in-hospital length of stay were longer in the operatively treated patients (6.3 and 13.3 vs. 4.7 and 7.7, respectively)” (p. 87).

Synthesis

This integrative review sought to determine best practice to improve treatment of the adult population aged 60 years or older with rib fractures by reviewing the evidence on the relationship between conservative or surgical treatment for rib fractures and morbidity and mortality outcomes. The most prevalent risk factors identified included age, injury severity, number of rib fractures, and comorbidities. Themes related to conservative and surgical treatment outcomes were also identified through data analysis. These themes included improved

outcomes and increased hospital length of stay with surgical treatment for rib fractures, among less prevalent themes.

The demographic characteristics that impact outcomes related to morbidity and mortality in older adult rib fracture patients also highlight the need for careful screening of patients when determining appropriate treatment options (Coary et al., 2020; Ho et al., 2020; Janssen et al., 2019; Peek et al., 2022; Peek et al., 2020; Prins, Wijffels, Wooldrik, et al., 2021; Vledder et al., 2019). Both the National Surgical Quality Improvement Program of the American College of Surgeons and the Surgical Quality Improvement Program of the Department of Veterans Affairs provide morbidity and mortality calculators to measure patient risk for certain outcomes (Bass et al., 2023). However, these evaluation measures were primarily designed for elective operations and may not accurately represent the risk that wounded patients face, particularly those with dangerous injuries such as rib fractures (Bass et al., 2023). In addition, senior age and the interaction of comorbidities may diminish the accuracy of geriatric predictions. Developing more comprehensive tools that better account for patient comorbidities may facilitate more reliable recommendations (Bass et al., 2023; Martin et al., 2019). Due to the heterogeneity of rib fracture patients, subgroup analysis is important to identify appropriate treatment plans (Peek et al., 2020).

Ethical Considerations

Systematic literature reviews can involve ethical issues that must be considered throughout the process. Researchers must respect the participants' right to privacy and ensure that the information gathered from these studies was used ethically and within the scope of the original consent (e.g., Booth et al., 2016). Systematic reviews should be conducted with equity in

mind, considering the potential impact of the research on vulnerable populations and ensuring that the findings remain applicable to a diverse range of individuals (Booth et al., 2012).

The project leader addressed this issue by discussing the population's interest respectfully when presenting the results of the integrative review and by not using language to demean or patronize older individuals. The project leader considered such instances of demeaning language in the included studies and took the language of the article into account when considering the quality of the study. Finally, researchers must be transparent about potential conflicts of interest when conducting a systematic review (Booth et al., 2012). The project leader in this integrative review had no financial ties to a company with an interest in the results of this integrative review.

Section Six: Discussion

This project's overall aim was to identify what various empirical results suggest regarding the extent to which various demographic factors might confound the association between treatment type, morbidity, and mortality. With this information, the medical and health care industries could be more aware of what factors to focus on when designing treatment regimens for older adult patients. This section summarizes the findings and presents their interpretation, implications, limitations, and a conclusion.

Discussion of the Findings

This integrative review sought to determine if there was evidence on how conservative or surgical treatment for rib fractures impacted morbidity and mortality outcomes among the adult population aged 60 years or older. The studies included in this integrative review identified several demographic factors associated with morbidity and mortality among older adult rib fracture patients when adjusted for covariates. The most prevalent risk factors identified were age, injury severity, number of rib fractures, and comorbidities.

Seven of the 15 studies identified age as a factor that increased the likelihood of morbidity and mortality related to rib fractures among older adult patients. Injury severity was an equally prevalent characteristic that impacted an older adult individual's likelihood of experiencing morbidity or mortality. Studies also commonly cited the number of rib fractures as a significant characteristic impacting morbidity and mortality. Six of the 15 studies indicated that the number of rib fractures was relevant to a patient's morbidity and mortality. The presence of comorbidities was the final demographic characteristic that studies found to increase the risk of morbidity and mortality among older adult rib fracture patients. Five of the 15 studies reported that comorbidities increased morbidity and mortality.

Four of the fifteen studies found improved outcomes related to surgical treatment of rib fractures compared to conservative treatment. However, these studies also found that the surgical option was associated with increased time spent in the hospital and increased costs. Based on the inconclusive evidence presented in this integrative review, the degree to which conservative and surgical therapies contribute separately to lowering morbidity and death in older patients with numerous rib fractures is still unknown.

Interpretation of the Findings

Demographic Factors That Impact Morbidity and Mortality Outcomes

This integrative review found that age was a major factor that increases the likelihood of morbidity and mortality related to rib fractures among older adult patients. Older adults who suffer injuries in the ribs have twice the mortality of younger individuals with similar injuries. Older adults have a high morbidity rate because children have more elastic ribs, which reduces the likelihood of fractures. According to Chen et al. (2022), people over 55 years of age experience longer hospital stays because they take more time to heal from surgical wounds.

Pulmonary complications such as pneumonia are also high among elderly people after surgical treatment. Gerakopoulos et al. (2019) stated,

The dramatic increase in the number of ventilator days, length of ICU [intensive care unit] stays, and length of hospital stay among the elderly with three to six rib fractures also reflects the increased complication rate and cost in caring for these patients. (p. 10)

Injury severity, the number of fractured ribs, the number of fracture sites, and bilateral rib fractures are significant risk factors among elderly people. MRFs put the life of the patient in danger. According to this integrative review findings, for patients over 65, every rib fracture increases the risk of developing pneumonia by 27% and mortality risk by 20%. Rib fractures in older adults can be severe due to chronic health conditions and reduced self-awareness. In line with this integrative review, Comas-Calonge et al. (2017) highlighted that infection and thoracic morbidity increase in older adults. The number of rib fractures is also relevant to a patient's morbidity and mortality. The ribs of older adults are not elastic like children's; thus, they are more likely to suffer multiple fractures. When older adults suffer MRFs, their breathing becomes shallower, and they repress coughing, which leads to respiratory insufficiency. In support of this integrative review, Wijffels et al. (2019) stated that older adult patients with rib fractures had a high prevalence of comorbidities such as diabetes, heart disease, and dementia. Older adults require more days of respiratory support and experience a prolonged hospital stay.

Improved Outcomes with Surgical Treatment for Rib Fractures

Four of the fifteen studies found improved outcomes related to surgical treatment of rib fractures compared to conservative treatment. For example, Ferrari et al. (2022) reported, "The mortality rate, considered the primary outcome, was higher in the conservative-treated group than the operatively treated patients (8.3% vs. 3%)" (p. 87). In patients over 60 years of age,

surgical treatment of MRFs can ease acute pains in the chest, lower the risks of other conditions such as pneumonia, and reduce hospitalization compared to conservative treatment. Surgical treatment improves the speed of recovery and patients' quality of life. In line with the findings of this study, Comas-Calonge et al. (2017) argued that surgical treatment resulted in quicker recovery and reduced risks of other complications for patients with MRFs. Furthermore, Comas-Calonge et al. stated that surgical treatment led to better prognoses than conservative treatment.

The results of this integrative review indicated that about 20% of people aged above 60 years with chronic diseases had experienced MRFs, which are associated with FC due to lack of rib support in the chest. The outcome of FC is paradoxical chest wall movement that causes life-threatening conditions such as hemodynamics disorders and acute respiratory distress syndrome, which increases mortality among this population (Bydon et al., 2019). Many physicians have used conservative treatment for MRFs due to insufficient medical evidence on the safety of surgical treatment. However, due to technological developments in recent years, as shown by this integrative review's results, there has been an advancement in anesthetic and surgical techniques; hence, more physicians now prefer surgical treatment for MRFs. Physicians believe that internal fixation of the chest wall will restore the stability of the chest, redevelop the chest volume, and improve the pulmonary function of the patients. According to Chen et al. (2022), surgical treatment improves the prognosis of patients, thus leading to a reduced hospital stay and fewer cases of chest deformity. In support of this study, van de Wall et al. (2020) suggested that surgical treatment for MRFs resulted in fewer intensive care unit admissions and hospital stays. Surgical rib fixation can reduce the duration of mechanical ventilation in individuals with MRFs. Even the Eastern Association for the Surgery of Trauma (2017) and the Western Trauma

Association urged U.S. physicians to use internal fixation and operative rib reduction for MRFs patients who could respond to mechanical ventilation treatment poorly.

The internal fixation and open reduction methods for severe rib fractures and thoracic trauma have gained popularity. Patients who undergo this complicated surgery report that 72 hours after surgery for a rib fracture, the pain in the chest is reduced, and their respiratory movement changed to normal from shallow. Surgically treated patients can comfortably cough and work independently without mechanical support. Surgical treatment reduces mortality, intensive care time, and infection to other body parts. Patients and physicians can choose surgical treatment when handling rib fractures to achieve more humane and effective treatment. Surgical treatment ensures that the fractured end of the rib can reach anatomical reduction, thus restoring the shape of the chest and reducing the tracheotomy rate.

Increased Hospital Stay with Surgical Treatment for Rib Fractures

Although surgical treatment was effective in treating patients with MRFs, this integrative review also established that surgical treatment is costly and might increase the time patients spend in hospitals. Managing pain throughout treatment is important when patients suffer MRFs. During the surgical treatment, patients might have trouble sleeping and coughing due to the pain, which increases the likelihood of pulmonary infection, thus increasing hospital stay. Physicians use narcotics and ketamine to relieve this pain. In line with the findings of this study, Sborov et al. (2022) suggested that patient-controlled intravenous analgesia (PCIA) can reduce patients' stress during the surgery and help them to comfortably cough. PCIA plays a huge role in lowering pulmonary infections associated with surgical treatment, thus shortening patients' hospital stays. Correcting the paradoxical breathing with the fixation of the fractured ribs can lessen the pain. Compared to conservative treatment, surgical treatment has the advantage of

controlling the floating of the chest wall; however, other infections resulting from the surgery can prolong patients' hospital stays. PCIA has been used to prevent and reduce the duration of these infections.

The cost of surgical treatment for a rib fracture is higher than conservative treatment. The cost of rib fracture treatment ranges from \$4,432 to \$17,105, which is very costly for families nationwide. Since 2000, the cost of rib fracture surgical treatment has increased due to technological development (Ling-Wen et al., 2021). The longer patients stay in inpatient units, the higher the cost. Surgical treatment costs also increase due to other infections that might arise during treatment. Surgical treatment is expensive, especially for patients with MRFs.

A significant challenge of implementing surgical treatment for rib fractures, especially for older people, is limited resources. Surgical interventions have not been cost-effective, especially for low-income groups. According to Ling-Wen et al. (2021), rib fracture surgery might require more than two physicians, especially when robotics is used, due to the need to have one doctor at the joystick and another provider supervising and standing near the surgery table. Because rib fracture surgical repair is a complex surgery and uses more resources, the costs run significantly higher than conservative therapy. Some insurance companies do not cover this procedure. Surgery is performed using the latest and most costly technologies to ensure quality outcomes for patients.

Furthermore, expensive medications are used throughout the process, including for pain management. Additionally, around-the-clock nursing care is often necessary to ensure patients do not suffer a recurrence. Patients are also offered recovery under the watch of physicians. Recovery is done on an inpatient basis, thus increasing the fee for a prolonged hospital stay.

After surgery for a rib fracture, physical and occupational therapies must be offered as part of the recovery process. Physical and occupational therapies are designed to help patients get on their feet as soon as possible and return to their normal activities. These therapies also increase the cost of surgical treatment. In support of these findings, Sawyer et al. (2022) stated that the hospital recovery room, called the post anesthesia care unit, allowed patients to recover from surgery under close observation by nursing and anesthesia. Patients are charged separately for the time spent in the post anesthesia care unit and the medications used. Together with other costs, this recovery makes surgical treatment expensive. Regardless of the effectiveness of surgical treatment compared to conservative treatment, it is costly, especially for low-income groups.

Presence of Co-Occurring Injuries and Conditions Limited Surgical Fixation Option

The findings of this integrative review have established that in recent years, the use of surgical treatment over conservative treatment for serious injuries such as rib fractures has gained popularity in the health care industry. However, the emergence of co-occurring injuries during surgeries has limited the use of surgical treatment. Different complications, such as deep vein thrombosis (DVT), might arise after surgeries. According to Rockne et al. (2021), during surgical operations, surgeons can cause physical damage to veins inside the chest, thus causing the patient to develop DVT. These postoperative complications are specific to the type of surgery performed.

The complications after a rib fixation include bleeding, nonunion, irritation, and infection. These plate fixation complications have limited the adoption of surgical treatment for patients with rib fractures. Patients also suffer from infections. However, Rockne et al. (2021) highlighted that strong antibiotics could treat infections. Patients have also reported experiencing

fracture-related infections after rib fracture surgery. Infections can result from compromised fracture healing, prolonged antibiotic therapy, and decreased functionality. Indeed, as established by Sedaghat et al. (2021), revision surgery was required for half of the patients who participated in the study due to infections. The problem of infection remains a big concern associated with surgical treatment, which needs to be addressed to increase the effectiveness of this treatment method.

Patients undergoing surgical treatment for rib fracture have a significant risk of developing pulmonary complications like pneumonia. One theme noted in the integrated review is that the pain patients experience during surgery could lead to insufficient ventilation and poor airway clearance. Although the main aim of rib fixation through surgery is to reduce pain by restoring the stability of the chest, the risk of pulmonary complications cannot be denied. Chen Zhu et al. (2020) noted that patients using the conservative method to treat rib fractures reported fewer pneumonia cases than those who had undergone surgery. After failure of conservative treatments, surgical treatment resulted in higher tracheostomy rates and increased patients' days on mechanical ventilation. Although rib fixation can reduce pain and improve patient outcomes, pulmonary complications remain a major concern that needs to be addressed by physicians.

No Difference Between Surgical and Conservative Outcomes

In recent years, surgical treatment outcomes have been positive in the treatment of serious injuries like rib fractures in older adults. However, there is not much difference between conservative and surgical treatment methods. The aging shows that surgical treatment may not always be an effective way to treat rib fractures among older adults. In agreement with this study, Gerakopoulos et al. (2019) stated that rib fractures are associated with a high mortality

rate without surgery and suggested that surgery should be performed regardless of effectiveness because surgical treatment has a low mortality rate.

Like surgical treatment, conservative treatment is also associated with positive results in the treatment of rib fractures. According to Gerakopoulos et al. (2019), conservative therapy, such as rest, ice, and appropriate analgesia, can treat isolated rib fractures. An incentive spirometer is highly recommended during conservative therapy to prevent pulmonary splinting and atelectasis. Like surgical treatment, conservative therapy uses intercostal nerve blocks to control pain effectively. Rib taping is not recommended because it affects the inspiratory effort. However, Chen et al. (2022) noted that conservative therapy is ineffective in patients with severe rib fractures and MRFs. Therefore, in cases of MRFs, surgical treatment is recommended. Early operative intervention is recommended during the surgical treatment for better outcomes and avoidance of mechanical ventilation.

Both surgical treatment and conservative therapy can be performed either inpatient or outpatient depending on the severity of the injuries. Conservative therapy is effective with less severe injuries, as patients do not need further interventions beyond pain control, ice, and enough rest. Multiple fractures require inpatient monitoring to control respiratory failure. Older people with rib fractures require closer monitoring due to the high mortality rate compared to younger individuals.

Implications

This integrative review has established that age increases the likelihood of morbidity and mortality related to rib fractures among older adult patients. Compared to children, older adults have a high chance of experiencing infections and pulmonary complications. However, early, and adequate pain management by health care providers helps prevent pulmonary complications.

The choice of analgesia depends on the care provider's experience and the injury's extent. Older people experience more rib fractures because their ribs are less elastic than children's. Therefore, it is recommended that they use an incentive spirometer intermittently throughout the day after taking analgesia. For example, holding pillows against fractures can reduce coughing discomfort (Xiao et al., 2020). Patients with multiple fractures experience compromised ventilation; hence, they need pulmonary support and invasive treatments. Caregivers should manage MRFs using different anesthesia techniques such as paravertebral block, continuous epidural infusion, and intercostal nerve blocks.

Surgical treatment is more effective in treating rib fractures than conservative therapy for older adults. Surgery in patients with rib fractures helps restore the shape of the chest and reduces breathing complications. According to Sborov et al. (2022), the mortality rate of patients with MRFs is reduced through surgical treatment. Hospitals should adopt surgical treatment over conservative treatment for patients with severe injuries. More education and training are needed to equip physicians with knowledge and skills to assess, optimize, and manage surgical operations among older patients. A training module on geriatric anesthesia should be provided for medical students, so care providers can know how to manage pain in surgical patients.

Furthermore, the perioperative care of older adult surgical patients should be included in surgical training curricula at all levels, beginning with undergraduate programs. During a typical general surgery training program, trainees receive practical experience caring for older surgical patients who have undergone elective and emergency surgery. The pre- and perioperative aspects of diagnosis and management in this vulnerable patient group are frequently neglected in favor of technical aspects of training that are inconsistent, unstructured, and concentrated on technical issues.

Limitations

There was a limited amount of literature found to support this topic. This impacted the generalizability of the findings. This integrative review utilized secondary data from existing studies, it was exposed to increased research bias. There was a substantial risk of recall and observer bias due to overreliance on self-reported data. Another limitation was that the rib fracture treatment process is complex, and choosing an appropriate treatment method remains daunting. This integrative review established no difference between surgical and conservative therapy in the treatment of rib fractures.

Conclusion

The overall aim of this integrative review was to identify what empirical results suggested regarding the extent to which several factors might confound the association between rib fracture treatment type, morbidity, and mortality. With this information, the medical and health care industries could be more aware of what factors to focus on when designing treatment regimens for older adult patients. Data analysis was conducted using Whittemore and Knafl's (2005) five steps: problem identification, literature search with inclusion and exclusion criteria, data evaluation, data analysis through reduction and extraction, and presentation.

Seven of the 15 studies identified age as a factor that increased the likelihood of morbidity and mortality related to rib fractures among older adult patients. In all seven of these studies, patients with more advanced age were at a greater risk for experiencing negative outcomes after being treated at the hospital for fractured ribs. Injury severity was an equally prevalent characteristic that impacted an older adult individual's likelihood of experiencing morbidity or mortality. Studies also commonly cited the number of rib fractures as a significant

characteristic impacting morbidity and mortality. Six of the 15 studies indicated that the number of rib fractures was relevant to a patient's morbidity and mortality.

This integrative review established that people over 55 years of age experience longer hospital stays because they take more time to heal from surgical wounds. In patients over 60 years, surgical treatment of MRFs could better ease acute pains in the chest, lower the risks of other conditions (e.g., pneumonia), and reduce hospitalization as compared to conservative treatment. Although surgical treatment was effective in treating patients with MRFs, this integrative review established that surgical treatment is costly and might increase the time patients spend in hospitals. The emergence of co-occurring injuries during surgeries limited the use of surgical treatment. Different complications, such as DVT, might arise after surgeries. Based on the findings of this integrative review, it is inclusive if surgical treatment or conservative measures are best practices. It was found that it is important to conduct a thorough patient assessment including co-morbidities, and demographic data when making a decision as to selecting a patient centered course of treatment.

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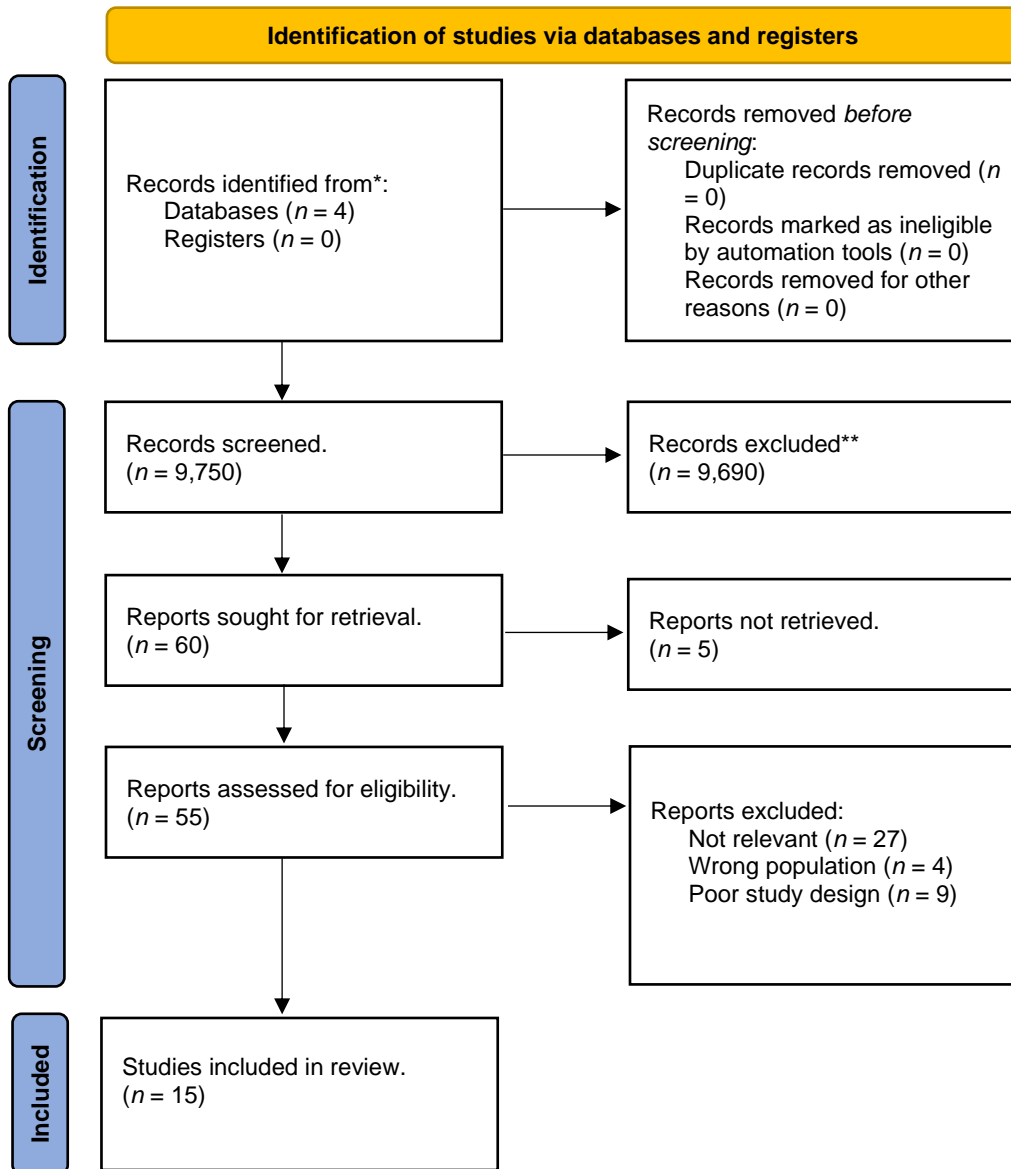
fractures (FixCon): Protocol for a multicenter randomized controlled trial. *World Journal of Emergency Surgery*, 14, Article 38. <https://doi.org/10.1186/s13017-019-0258-x>

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Appendix A

Prisma Diagram



From “The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews,” by M. J. Page, J. E. McKenzie, P. M. Bossuyt, I. Boutron, T. C. Hoffmann, C. D. Mulrow, L. Shamseer, J. M. Tetzlaff, E. A. Akl, S. E. Brennan, R. Chou, J. Glanville, J. M. Grimshaw, A. Hróbjartsson, M. M. Lalu, T. Li, E. W. Loder, E. Mayo-Wilson, S. McDonald, . . . D. Moher, 2021, *BMJ*, 372, Article 71. (<https://doi.org/10.1136/bmj.n71>)

Appendix B

Evidence Table

Author (year)	Study purpose/objective(s)	Design, sampling method, & subjects	LOE *	Intervention & outcomes	Results	Study strengths & limitations
Gerakopoulos et al. (2019)	This research was to assess and investigate the effectiveness of surgical fixation of rib fractures (RFs) in complex traumatic chest injuries compared to nonoperative management.	Quantitative retrospective observational comparative research design. Purposive sampling was used to recruit a sample of eighty-three patients urgently admitted at Level 1 major trauma center in Northwest England.	Level III	Open reduction and internal fixation (ORIF) of multiple fractures and flail chest segments versus traditional nonoperative management. The primary outcome was the total length of stay (LOS) in the hospital while incidences of respiratory complications including tracheotomy, hospital-acquired pneumonia and need for mechanical ventilation were secondary outcomes.	Forty-seven of the eighty-three patients were assigned to ORIF group while thirty-six were in non-ORIF group. In the ORIF group the hospitals' LOS was significantly reduced (30.41 days to 14.53 days). The incidences of respiratory complications and mortality in ORIF group was markedly lower although the difference was statistically insignificant.	The study was limited by the lack of randomization and its retrospective nature. The second limitation was the small sample size, and the third limitation was sample bias. The strengths of the study included three trauma and orthopedics consultants performed the surgical fixation, standardized modalities used in the non-operative management increased the study's reliability and the demographic characteristic for the two groups was well balanced.
Chen, S.-A., Liao, C.-A., Kuo, L.-W., Hsu, C.-P., Ouyang, C.-H., & Cheng, C.-T. (2022). The surgical timing and complications of rib fixation for rib fractures in geriatric patients.	Researchers investigated the impacts of proper surgical timing on RF fixation of geriatric patients.	Quantitative retrospective analysis with a sample of 1078 patients from Chang Gung Memorial Hospital. Eighty-seven patients underwent RF fixation.	Level III	The intervention measure was RF fixation. Primary outcome was mortality, length of hospital stays, length of intensive care unit (ICU) stays, and need for tracheostomy.	The findings revealed that in geriatric patients, complications due to RF fixation were due to severity of the injury rather than surgical timing and age. Multivariate analysis revealed that early fixation decreased the stay	The limitations include the small sample size, the bone healing mechanisms are complex and patients with high mean platelet volume needed additional surgical intervention. The second limitation was associated with the retrospective analysis and limitation three was based on the un-insured

Author (year)	Study purpose/objective(s)	Design, sampling method, & subjects	LOE *	Intervention & outcomes	Results	Study strengths & limitations
<i>Journal of Personalized Medicine</i> , 12(10), Article 1567. https://doi.org/10.3390/jpm12101567		Multivariate analysis was performed			length in hospital and ICU and minimized the need for tracheostomy.	RF fixation devices increasing the likelihood of patients refusing to participate. Future researchers should consider increasing the number of participants.
Hoepelman, R. J., Beeres, F. J., Heng, M., Knobe, M., Link, B.-C., Minervini, F., Babst, R., Houwert, R. M., & van de Wall, B. J. (2022). Rib fractures in the elderly population: A systematic review. <i>Archives of Orthopaedic and Trauma Surgery</i> , 143(2), 887–893. https://doi.org/10.1007/s00402-022-04362-z	The purpose of this study is to review literature on RFs in the elderly population.	The method used was systematic review of literature. Reviewed studies were retrieved from CINAHL, PubMed, Embase, Medline and CENTRAL databases. Randomized controlled clinical trials and observational studies were reviewed. Five studies were included in the review.	Level I	The intervention measure was operative and conservative treatment of RFs. The primary outcome was mortality and rates of contracting pneumonia.	The results indicated that following operative treatment of RFs, mortality was decreased in addition to reduced rates of contracting pneumonia.	The limitation associated with this study was the randomized controlled studies and comparative observations were not defined clearly. Another limitation is that the reviewed studies were not balanced and as such pooling of data was not feasible for meta-analysis. However, the strength of the study was the fact that the results were applicable to a wide spectrum of elderly patients.
Liu, X., & Xiong, K. (2019). Surgical management versus non-surgical management of rib fractures in chest trauma: A systematic review and meta-analysis. <i>Journal of Cardiothoracic Surgery</i> , 14,	The researchers compared the effectiveness of non-surgical and surgical management of RFs following chest trauma	The method used was systematic review of literature and meta-analysis. Peer reviewed articles were retrieved from PubMed, Embase and Cochrane library. Fourteen peer reviewed studies with a total	Level I	The intervention measures were surgical and non-surgical management of RFs. The study outcomes include mortality rate, tracheotomy, pulmonary infection rate, mechanical ventilation time and hospitalization time.	Surgical management of RFs decreased patient mortality, minimized the time needed for mechanical ventilation and tracheotomy. The surgical management also reduced the length of hospital and ICU stay besides	The first limitation: it was difficult to design high quality research given the non-randomization of participants in study groups. Second, it is difficult to differentiate between prospective trials and retrospective research studies. The strength of this study was the comparability of reviewed studies that

Author (year)	Study purpose/objective(s)	Design, sampling method, & subjects	LOE *	Intervention & outcomes	Results	Study strengths & limitations
Article 45. https://doi.org/10.1186/s13019-019-0865-3		patient sample of 839 were analyzed.			minimizing pulmonary infection.	justified the pooling of individual evidence.
Liu, Y., Xu, S., Yu, Q., Tao, Y., Peng, L., Qi, S., Han, H., & Chen, M. (2018). Surgical versus conservative therapy for multiple rib fractures: A retrospective analysis. <i>Annals of Translational Medicine</i> , 6(22), 439–439. https://doi.org/10.21037/atm.2018.10.12	The purpose of this research was to compare between surgical rib fixation and conservative therapy.	Quantitative retrospective analysis was conducted between June 2014 and December 2016. 110 patients were recruited from the hospital. Fifty-one patients were treated with conservative treatment while 59 received surgical treatment.	Level III	The intervention measures were surgical rib plate fixation and conservative management. The primary outcome was LOS in ICU while hospitalization costs represented the secondary outcome.	The results indicated that patients who underwent surgical rib plate fixation reported decreased LOS in the thoracic ICU 13.12 days to 4.02 days compared to 5.85 days in conservative management. In terms of treatment costs, surgical rib plate fixation was expensive \$6,206 when compared to \$4,544 for conservative management.	One potential limitation was inherent in the retrospective analysis used and small sample size. The strengths were the homogeneity of the sample. Future researchers should consider using larger sample sizes in addition to conducting large multi-trial studies.
Long, R., Tian, J., Wu, S., Li, Y., Yang, X., & Fei, J. (2020). Clinical efficacy of surgical versus conservative treatment for multiple rib fractures: A meta-analysis of randomized controlled trials. <i>International Journal of Surgery</i> , 83, 79–88. https://doi.org/10.1	This study examined the efficacy of conservative management and surgical treatment in the treatment of multiple RFs.	A meta-analysis of randomized controlled trials. Peer reviewed articles for meta-analysis were retrieved from Embase, Medline, PubMed, CINAHL, Cochrane and Wanfang databases. Multiple RFs were treated as either internal fixation or operative reduction.	Level I	The intervention assessed were surgical rib fixation and conservative management. The primary outcomes were LOS, duration of mechanical ventilation, risks of pulmonary complication including chest wall deformity.	The results indicated that compared to conservative treatment, surgical treatment of multiple RFs decreased both LOS in hospital and ICU, duration needed for mechanical ventilation and risks of pulmonary complication.	The first limitation was that all meta-analyzed randomized control trials were single center, lack of unified timing of hospital discharge was also a significant limitation. Heterogeneity was also found to influence the outcome of the study.

Author (year)	Study purpose/objective(s)	Design, sampling method, & subjects	LOE *	Intervention & outcomes	Results	Study strengths & limitations
016/j.ijsu.2020.09.010		Seven randomized control trials were meta-analyzed.				
Otaka, S., Aso, S., Matsui, H., Fushimi, K., & Yasunaga, H. (2020). Effectiveness of surgical fixation for rib fractures in relation to its timing: A retrospective Japanese nationwide study. <i>European Journal of Trauma and Emergency Surgery</i> , 48(2), 1501–1508. https://doi.org/10.1007/s00068-020-01548-1	This study examined the relationship between surgical fixation effectiveness and timing in treating RFs.	Retrospective analysis of 8922 patients. Patients were identified from the Japanese Diagnosis Procedure Combination analysis from July 1, 2010, to 31 March 2018.	Level III	The intervention measure was surgical rib fixation. The primary outcomes were post rib-fixation, length of hospital stay and duration of mechanical ventilation. Secondary outcomes included post-admission pneumonia, tracheostomy and all-cause 28 day in-hospital mortality.	The results indicated that within three days of admission, surgical rib fixations reduced the duration for mechanical ventilation and decreased the length of hospital stay. Overall, compared to later surgical fixation, early surgical fixation led to positive health outcomes.	The research was limited by the unavailability of information on patient RF, inconsistencies in surgical rib fixation indications, small sample size and the appropriate timing for surgical fixations was a challenge.
Owattanapanich, N., Lewis, M. R., Benjamin, E. R., Jakob, D. A., & Demetriades, D. (2022). Surgical rib fixation in isolated flail chest improves survival. <i>The Annals of Thoracic Surgery</i> , 113(6), 1859–1865. https://doi.org/10.1016/j.athor.2022.05.010	The researchers sought to investigate the impacts of surgical rib fixation for patients with flail chest	Retrospective observational study with a sample of 5293 patients with flail chest selected from the National Trauma Data Bank 2016-2017. Multivariate analysis was conducted to analyze the data.	Level III	The intervention employed in this research was rib fixation that was performed on 575 patients. The outcome of the study was mortality incidence for patients with flail chest injuries.	The researchers reported that operative fixation on patients with flail chest injuries recorded improved survival following a significant reduction in mortality rates. The results also indicated that though timing fixation did not influence mortality, early fixation decreased the need for	One of the strengths reported for this study was the use of large homogenous samples. Another strength was associated with the use of <i>ICD-10</i> specific for surgical rib fixation. Despite the benefits, potential limitations included challenges associated with retrospective research and the fact that the NTDB is limited to the information it can record.

Author (year)	Study purpose/objective(s)	Design, sampling method, & subjects	LOE *	Intervention & outcomes	Results	Study strengths & limitations
016/j.athoracsur.2021.05.085					lengthened mechanical ventilation. The results further indicated that compared to patients in nonoperative management, patients who underwent reported increased length of hospital stay and likelihood of undergoing tracheostomy in addition to increased incidences of venous thromboembolism and pulmonary embolism.	Limited data for coding was also a potential limitation.
Rockne, W. Y., Grigorian, A., Christian, A., Nahmias, J., Lekawa, M., Dolich, M., Chin, T., & Schubl, S. D. (2021). No difference in mortality between Level I and Level II trauma centers performing surgical stabilization of rib fracture. <i>The American Journal of Surgery</i> , 221(5), 1076–1081. https://doi.org/10.1016/j.amjsurg.2020.09.033	The purpose was to compare the outcomes of surgical stabilization of RFs in Level 1 and Level 2 trauma centers and the risks of patient mortality in the two trauma centers.	Quantitative retrospective analysis of the trauma quality improvement program. Multivariable logistic regression analysis was performed. Patients were identified using International Classification of Diseases Version 9 and Version 10. 14,046 of 199,020 RFs agreed to surgical stabilization of rib fracture (SSRF).	Level III	The intervention was Trauma Quality Improvement Program. The primary outcome is incidences of patient mortality.	The results revealed that SSRF increased from 1304 in 2010 to 3489 in 2015. Though the incidences of mortality following SSRF reduced in both LI and LII hospitals despite there being no significant differences in risk mortality.	Risks of bias and coding errors are key limitations as some comorbidities will not be captured. Another limitation was the lack of qualitative data. Future research should include the annual volumes of SSRF cases performed by each surgeon.

Author (year)	Study purpose/objective(s)	Design, sampling method, & subjects	LOE *	Intervention & outcomes	Results	Study strengths & limitations
Sawyer, E., Wullschleger, M., Muller, N., & Muller, M. (2022). Surgical rib fixation of multiple rib fractures and flail chest: A systematic review and meta-analysis. <i>Journal of Surgical Research</i> , 276, 221–234. https://doi.org/10.1016/j.jss.2022.02.055	Researchers sought to investigate the impacts of surgical rib fixation on multiple RFs and flail chest.	A systematic review of literature and meta-analysis was conducted. PRISMA guidelines were used to identify relevant peer reviewed articles for review. Forty-five papers were included in the systematic review while 40 were selected for meta-analysis.	Level I	The intervention was surgical rib fixation. The primary outcomes were LOS in ICU and hospital while mortality, mechanical ventilation and rates of pneumonia were identified as secondary outcomes.	The researchers after analysis revealed that compared to non-operative management, surgical fixation positively associated with decreased need for mechanical ventilation, reduced LOS in both ICU and hospital, decreased rates of mortality, need for tracheostomy and reduced risks of pneumonia. The results further showed that conservative management was important for patients aged 60 years and above as it decreased the need for mechanical ventilation and hospital LOS. Overall, surgical fixation of multiple RFs and flail chest reduced mortality and morbidity.	The study was limited by the number of studies retrieved for review and meta-analysis.
Sborov, K. D., Dennis, B. M., de Oliveira Filho, G. R., Bellister, S. A., Statzer, N., Stonko, D. P., Guyer, R. A., Wanderer, J. P., Beyene, R. T.,	The purpose of this research was to investigate whether acute pain consult, and management decreased mortality and morbidity for	The research method was a retrospective observational, propensity-matched cohort study with a sample of 2486 of whom, 621	Level IV	The intervention used was APS consultation. The primary outcome was to investigate the differences in hospital mortality while pulmonary	The findings revealed that the mortality rate for patients in APS consult was 1.8% compared to 6.6% in control patients. However, APS consultation was	The strength of the study was a large sample size that increased the study's reliability. However, the inability to collect all the relevant information because of the large sample size was

Author (year)	Study purpose/objective(s)	Design, sampling method, & subjects	LOE *	Intervention & outcomes	Results	Study strengths & limitations
McEvoy, M. D., & Allen, B. F. (2022). Acute pain consultation and management is associated with improved mortality in rib fracture patients. <i>Regional Anesthesia & Pain Medicine</i> , 47(10), 643–648. https://doi.org/10.1136/rapm-2022-103527	traumatic rib-fracture patients.	received Anesthesia Pain Service (APS) consult while 621 were control patients. The patients were identified and selected from trauma registry and electronic medical records.		comorbidity and LOS in hospital were identified as secondary outcomes.	found to increase both ICU and hospital LOS 1.19 days to 1.90 days and 1.61 days to 2.41 days, respectively. There were no differences in pulmonary complications in both groups.	identified as a major limitation.
Sedaghat, N., Chiong, C., Tjahjono, R., & Hsu, J. (2021). Early outcomes of surgical stabilization of traumatic rib fractures: Single-center review with a real-world evidence perspective. <i>Journal of Surgical Research</i> , 264, 222–229. https://doi.org/10.1016/j.jss.2021.02.026	This study's objectives were to investigate the early outcomes of surgical stabilization of traumatic RFs.	Quantitative single-center retrospective analysis of consecutive patients who underwent SSRF at the Westmead Hospital in Sydney, Australia. Participants were purposively selected from the trauma registry and surgeon logbooks. Sixty-three patients were recruited and allowed to participate in the study.	Level III	The primary outcome was LOS in the ICU while secondary outcome was wound infection following surgery. The intervention was SSRF.	The results revealed that the LOS for the 37 patients in ICU was significantly reduced following SSRF 15.5 days to 10.0 days. The number of patients requiring mechanical ventilation also reduced in both the ICU and general wards (46.5% versus 6.5%).	Small retrospective sample was a major limitation while use of real time data was the study's main strength.
Tang, W.-R., Chang, C.-C., Wang, C.-J., Yang, T.-H., Hung, K.-S.,	This research's objective was to investigate the impacts of surgical	Quantitative comparative research with a sample of 1468	Level VI	The intervention measure was SSRF. The outcomes being investigated were	The results indicated that the duration of ventilator support and LOS was not	Small sample size and single-center experience were significant limitations. Future researchers should

Author (year)	Study purpose/objective(s)	Design, sampling method, & subjects	LOE *	Intervention & outcomes	Results	Study strengths & limitations
Wu, C.-H., Yen, Y.-T., Tseng, Y.-L., & Shan, Y.-S. (2022). Tailored surgical stabilization of rib fractures matters more than the number of fractured ribs. <i>Journal of Personalized Medicine</i> , 12(11), Article 1844. https://doi.org/10.3390/jpm12111844	stabilization for multiple RFs.	consecutive patients. 177 patients were treated using surgical rib fixation while 1,291 patients received conservative treatment.		pulmonary complications, LOS in hospitals and duration of ventilation support	influenced by the number of RFs. However, surgical rib fixation decreased the risks of pulmonary complications, delayed surgery, and LOS in both the ICU and hospital.	consider using large sample sizes.
Wijffels, M. M., Prins, J. T., Polinder, S., Blokhuis, T. J., De Loos, E. R., Den Boer, R. H., Flikweert, E. R., Pullter Gunne, A. F., Ringburg, A. N., Spanjersberg, W. R., Van Huijstee, P. J., Van Montfort, G., Vermeulen, J., Vos, D. I., Verhofstad, M. H., & Van Lieshout, E. M. (2019). Early fixation versus conservative therapy of multiple, simple rib fractures	This study investigated and compared the effectiveness of conservative therapy and early fixation in the treatment of multiple simple RFs.	Multi-center randomized controlled trial with 72 patients.	Level I	The intervention measures were early surgical rib fixation and traditional conservative management. The primary outcome of the research was pneumonia. Secondary outcome measures included duration for mechanical ventilation, levels of thoracic pain, recovery of pulmonary function, LOS, costs of treatment and health-related quality of life.	The findings revealed that operative procedures improved the health of flail chest patients in addition to reducing length of hospital stays, minimizing pulmonary complications, reduced pain, enhanced return to normalcy and improved quality of life.	Small sample size was the main limitation while the strength was the randomization of study participants.

Author (year)	Study purpose/objective(s)	Design, sampling method, & subjects	LOE *	Intervention & outcomes	Results	Study strengths & limitations
(FixCon): Protocol for a multicenter randomized controlled trial. <i>World Journal of Emergency Surgery, 14,</i> Article 38. https://doi.org/10.1186/s13017-019-0258-x Xiao, X., Zhang, S., Yang, J., Wang, J., Zhang, Z., & Chen, H. (2020). Surgical fixation of rib fractures decreases intensive care length of stay in flail chest patients. <i>Annals of Translational Medicine, 8</i> (5), Article 216. https://doi.org/10.21037/atm.2020.01.39	Researchers sought to examine surgical fixation of RFs decreased LOS for patients with flail chests.	Quantitative retrospective analysis. Simple random sampling was used to recruit 1,201 patients with multiple RFs.	Level III	The intervention was surgical rib fixation. The primary outcome was identified as LOS in hospital for multiple RF patients and ICU LOS for patients with flail chest injuries. The secondary outcome was hospital mortality, pneumonia, rate of ventilator usage, duration of ventilator support and ICU admission rates.	The researchers established that there were no statistically significant differences in primary and secondary outcome for patients with multiple RFs in both conservative and surgical rib fixation. Conversely, for flail chest patients, the results revealed that decreased ICU LOS, and secondary outcomes were associated with surgical rib fixation than conservative management.	The study was limited by the observational and retrospective methodology used that might have influenced the outcome of the study negatively. The short follow-up period limited adequate evaluation of regimen and associated complications. The researchers recommended the need for randomized controlled studies to address the limitations identified in the current study.

Appendix C

Collaborating Institutional Training Initiative Training Certificate



Completion Date 09-Nov-2022
Expiration Date 09-Nov-2025
Record ID 52651160

This is to certify that:

Adella Boeding

Has completed the following CITI Program course:

Biomedical Research - Basic/Refresher
(Curriculum Group)
Biomedical & Health Science Researchers
(Course Learner Group)
1 - Basic Course
(Stage)

Not valid for renewal of certification through CME.

Under requirements set by:

Liberty University



Verify at www.citiprogram.org/verify/?w95a0aaf6-b90b-4c20-9e48-364e963b6d6d-52651160

Appendix D**Institutional Review Board Letter****LIBERTY UNIVERSITY.**
INSTITUTIONAL REVIEW BOARD

April 27, 2023

Adella Boeding
Sharon Kopsis

Re: IRB Application - IRB-FY22-23-1433 Treatment of Rib Fractures in Elderly Patients in the Acute Care Setting: An Integrative Review

Dear Adella Boeding and Sharon Kopsis,

The Liberty University Institutional Review Board (IRB) has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds that your study does not meet the definition of human subjects research. This means you may begin your project with the data safeguarding methods mentioned in your IRB application.

Decision: No Human Subjects Research

Explanation: Your study is not considered human subjects research because it will not involve the collection of identifiable, private information from or about living individuals (45 CFR 46.102).

Please note that this decision only applies to your current application. Any modifications to your protocol must be reported to the Liberty University IRB for verification of continued non-human subjects research status. You may report these changes by completing a modification submission through your Cayuse IRB account.

If you have any questions about this determination or need assistance in determining whether possible modifications to your protocol would change your application's status, please email us at irb@liberty.edu.

Sincerely,

G. Michele Baker, PhD, CIP
Administrative Chair
Research Ethics Office