Research Article

Effectiveness Of Preventive Protocols For Post Traumatic Pneumonia Among Patients With Thoracic Trauma

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Abstract

Post-traumatic pneumonia (PTP) is a very common and severe complication of thoracic trauma. It is a significant risk factor for morbidity, mortality, hospital length of stay, admission to intensive care unit (ICU) and healthcare costs. Several preventive measures have been implemented to reduce the incidence of PTP, such as early mobilization, chest physiotherapy, incentive spirometry, pain management, oxygen therapy, pulmonary hygiene, infection control and multidisciplinary care of the patient. This article contains a critical assessment of the effectiveness of such preventive interventions from the evidence presented in the thesis. The results have confirmed that preventive protocols are very effective, if they are applied in a regular and systematic way and are carried out by a multidisciplinary team. The use of early assessment, ongoing respiratory monitoring and standardized clinical guidelines, along with effective collaboration between healthcare professionals, can greatly decrease the prevalence of pneumonia and enhance patient outcomes.

Keywords: Post-traumatic pneumonia, thoracic trauma, preventive protocols, early mobilization, chest physiotherapy, trauma care.

1. Introduction

Thoracic trauma continues to be one of the most important causes of morbidity and mortality in trauma patients globally and public health problems. Road traffic accidents, falls, occupational injuries, sports injuries and penetrating trauma often damage the chest leading to an impairment of respiratory function and the risk of life-threatening complications to the lungs (Mohamed Adam et al., 2025; Nevzghoda et al., 2024; Oribjonov, 2026). Post-traumatic pneumonia (PTP) is one of the most clinically important complications resulting from trauma and is linked with a longer hospital stay, greater intensive care unit (ICU) admission, higher healthcare costs, and mortality. Although trauma management and critical care have progressed significantly over the years, post traumatic pneumonia remains a significant burden on the health care system and impacts patient's recovery following thoracic trauma (Mohamed Adam et al., 2025; Lodhia et al., 2023; Hofman et al., 2020).

Pathogenesis of post-traumatic pneumonia is complex and attributed to various factors including severity of injury, compromised pulmonary mechanics, host immune response and hospital related factors (Howroyd et al., 2026; Vasse et al., 2023; Dogrul et al., 2020; El-Faramawy et al., 2020). Features of decreased lung expansion, poor cough, poor mucociliary clearance and secretion retention occur in patients with rib fracture, pulmonary contusion, pneumothorax, hemothorax and flail chest. Such changes lead to physiological changes that promote bacterial invasion and infection of the lungs (Coccolini et al., 2025; Dote et al., 2020; Cakmak et al., 2022). In addition, patients who have experienced thoracic trauma are more likely to develop pneumonia if they are immobilized for long periods of time, mechanically ventilated, elderly, have a chronic respiratory disease, a smoking history, diabetes mellitus, or weakened immunity (Freeman et al, 2022; Mohamed Adam et al., 2025; Caputo et al, 2024). Thus, early recognition of high-risk patients is still a critical factor in evidence-based trauma care.

Healthcare institutions have developed several protocols to reduce occurrence of PTP including early respiratory assessment, pain management, pulmonary hygiene, chest physiotherapy, incentive spirometry, oxygen therapy, prevention of aspiration, infection control and early mobilization (Kumar et al., 2020; Elnahla et al., 2021; Wu et al., 2024). The purpose of these interventions is to maintain lung function, facilitate drainage of secretions, minimize pulmonary complications and promote recovery (van Aswegen, 2020; Lorenzo et al., 2026). But, the implementation of successful measures requires not only the availability of preventive measures, but also timely clinical decision making, appropriate resources in the institution,

standard clinical guidelines, and good multi-professional teamwork between doctors, nurses, respiratory therapists and physiotherapists (Aswegen et al., 2020; El-Senousy et al., 2020; Robba et al., 2020).

These preventive measures are commonly used in most trauma centers, but there is significant variation in their application in health care delivery systems. Variations in clinical knowledge, staffing, resource availability, institutional policies and implementation of evidence-based guidelines could affect the success of pneumonia prevention programs (Ahmed et al., 2024; Jain & Waseem, 2026). Furthermore, the use of general infection prevention measures continues to be the norm in many healthcare settings and may be less effective when applied to patients with thoracic injuries, since there are no specific protocols for prevention (Jain & Waseem, 2025; De Moya et al., 2022; Muchnok et al., 2022).Also, many health care providers do not have trauma-specific infection prevention protocols, so generalized infection prevention measures may be less effective for patients with thoracic injuries (Yatera & Yamasaki, 2025; Al Tannir et al., 2024; Bradley et al., 2020). The gaps in current practice indicate the need for a systematic review of current preventive practice, and contribution to enhancing patient outcomes.

There is a wide-ranging body of literature regarding individual preventive interventions like early mobilization, chest physiotherapy and ventilator care bundles. Yet, there is relatively few evidence that is comprehensive and integrates a multidisciplinary approach to prevent all these preventive measures in thoracic trauma patients (Hemati et al., 2024; Jo, 2022; Shi et al., 2024). In addition, very little effort has been spent on comprehending the impact of various types of chest trauma on the development of pneumonia and the attitudes of health care workers regarding the effectiveness of the current pneumonia preventive strategies (Taran & Stevens, 2023; Réa-Neto et al., 2023; Chen et al., 2021). These gaps in knowledge can constrain the ability to develop evidence-based, standardized recommendations in various healthcare settings for preventing post-traumatic pneumonia (Ramsuchit et al., 2026; Lagazzi et al., 2024; Vasquez et al., 2020).

Hence, this study assessed the efficacy of the preventive measures taken to prevent post traumatic pneumonia in patients having thoracic trauma (Schieren et al., 2020; Beeton et al., 2023). In particular, the study highlights primary physiological and clinical risk factors for the development of pneumonia, explores the role of timely intervention and early detection, reviews existing prevention measures and explores the impact of various chest trauma on the risk of pneumonia (Deloney et al., 2021; Prins et al., 2021; Coccolini et al., 2024). This research is designed to support evidence-based clinical practice, assist in multidisciplinary decision-making and help develop uniform guidelines for prevention that enhance patient outcomes and minimize respiratory morbidity after thoracic trauma by delivering empirical evidence from healthcare professionals on the ground working with trauma patients (Mahmood et al., 2020; Rossaint et al., 2023; Gour-Provencal et al., 2021).

2. Literature Review

2.1 Post-Traumatic Pneumonia

One of the most frequent respiratory post-thoracic trauma complications is post-traumatic pneumonia (PTP) and remains a significant challenge in trauma care. It occurs after injuries which impair the normal pulmonary function such as rib fracture, pneumothorax, hemothorax, and flail chest (Zhao et al., 2025; Kithinji et al., 2022; Cárcamo Arévalo et al., 2026). Such injuries result in decreased lung expansion, ineffective coughing and leading to a tendency to retain respiratory secretions, which leads to favorable conditions for the growth of bacteria and pulmonary infection (Oribjonova, 2026; Werle et al., 2026; Magaldi et al., 2026). Patients with PTP are invariably found to be hospitalized for longer, intensive care unit (ICU) admitted, more expensive to treat, not as functional as other patients and dying at a higher rate. Therefore, prevention is now a key goal of trauma care, as well as treating infection once it occurs (Kilinc et al., 2026; Han et al., 2026; Temurovna, 2026; Sumaarsana et al., 2026). Despite advances in emergency medicine, surgical treatment and critical care, severely injured patients continue to have a high incidence of respiratory complications. The evidence available to date suggests that trauma causes physiological changes that compromise the pulmonary defenses, and that early in the hospital stay patients are especially susceptible to this (Matias & Abreu, 2026; Pillai et al., 2026; Lytvynenko et al., 2026). Thus, knowledge of the mechanisms underlying the development of pneumonia is an important basis for designing effective pneumonia prevention strategies.

2.2 Pathophysiology of Post-Traumatic Pneumonia

After a chest injury, there are several physiological mechanisms which act together to create a process of post-traumatic pneumonia. Trauma causes injury to pulmonary tissues and impacts normal respiratory mechanics which leads to decreased ventilation, impaired mucociliary clearance, mucus retention and decreased oxygen exchange (Enright et al., 2026; Ruiz et al., 2026; Rezaei et al., 2026). Pulmonary confusion leads to alveolar oedema and inflammatory response which disrupts normal gas exchange, and rib fractures mean that chest wall movement is restricted due to the high levels of pain at the fracture site (Sobrinho & da Costa, 2026; Kurt et al., 2026). These modifications in all combine to make the patient less capable of coughing effectively and lead to the build-up of microorganisms in the lower respiratory tract. Another risk of mechanical ventilation is that it bypasses the natural defense mechanisms of the airways, increasing the risk of pneumonia. ETTs allow bacteria to enter

the lower respiratory tract and raise the risk of ventilator-associated pneumonia (VAP) especially in the critically injured patient who may need to be supported on a ventilator for more than two days (Bayraktar et al., 2026; Chen et al., 2026; Patil et al., 2026). During intensive care, medications are often given to help the patient's body relax and this also reduces the cough reflex and further impairs clearance of secretions, which creates conditions ideal for bacteria to grow. A second, and additional, factor is that the body's immune system may be temporarily weakened after trauma, making it less able to fight off the invasion of any foreign pathogens (Alharran et al., 2026; Djanie et al., 2026). The relationship of these mechanisms is responsible for the fact that even with the improvements in trauma care, post-traumatic pneumonia is still difficult to prevent.

2.3 Clinical Risk Factors Associated with Post-Traumatic Pneumonia

There are many physiological and clinical features that can affect the risk of post-traumatic pneumonia. One of the most important predictors is the degree of injury severity (patients with multiple rib fractures, pulmonary contusions, pneumothorax, hemothorax or 'flail chest' have significantly increased risk due to the decreased ability to ventilate and function and protect their airway). Poorly controlled pain reduces deep breathing and coughing and allows the retention of secretions which leads to infection (Portaccio et al., 2026; Mohamed Adam et al., 2025; Nevzghoda et al., 2024). Other factors associated with the patient play a major role in susceptibility to pneumonia. The following factors have been found to be important predisposing factors: advanced age, smoking history, chronic respiratory diseases, diabetes mellitus, malnutrition, reduced consciousness, aspiration risk, and prolonged immobilization (Zhang et al., 2024; Oribjonov, 2026; Lodhia, 2023). In addition, the hospital-acquired pathogens that are encountered by critically injured patients who are on mechanical ventilation for prolonged periods will increase the incidence of ventilator-associated pneumonia (Hofman et al., 2020; Howroyd et al., 2026). These factors must be recognised so that interventions to prevent clinical deterioration can be started at the appropriate time and in suitable patients (Vasse et al., 2023; Dogrul et al., 2020; El-Faramawy et al., 2020).

2.4 Preventive Protocols in Thoracic Trauma Care

Many preventive measures have been taken by healthcare organizations so that the occurrence of PTP among patients with thoracic trauma can be diminished. Such guidelines focus on thorough respiratory evaluation on admission to hospital, ongoing monitoring of oxygen saturations, assessment of pain, pulmonary hygiene, early mobilization, preventing infection and aspiration, managing patient care in a multi-disciplinary way (Coccolini et al., 2025; Dote et al., 2020; Cakmak et al., 2022). Instead of relying on a single intervention, much evidence-based practices should be coordinated throughout hospitalization to ensure successful prevention. Early mobilization has proven to be one of the most recommended interventions as it has been shown to promote pulmonary ventilation, increase clearance of secretions, decrease atelectasis and decrease the complications of prolonged bed rest (Freeman et al., 2022; Caputo et al., 2024; Kumar et al., 2020). Chest physiotherapy, breathing exercises and incentive spirometry also help to clear the airways, enhance lung expansion and performance of the respiratory muscles. With good pain control, patients can actively engage in physiotherapy and breathing exercises, while the strict infection control limits exposure to hospital acquired infections (Elnahla et al., 2021; Wu et al., 2024; van Aswegen et al., 2020). Combined interventions are the backbone of current modern day PTP prevention programs.

2.5 Role of Multidisciplinary Collaboration

There is a great need for the cooperation of healthcare professionals from various clinical disciplines for effective prevention of post-traumatic pneumonia. During patient management, these healthcare professionals bring their expertise of different fields from physicians, nurses, respiratory therapists, physiotherapists, emergency physicians, anesthesiologists and intensive care specialists (Lorenzo et al., 2026; Aswegen et al., 2020; El-Senousy et al, 2020). Physicians diagnose, determine the treatment strategy and supervise the overall clinical management, whereas nurses continuously monitor patients and identify early warning signs which need immediate intervention, such as assessing their respiratory status, checking their oxygen saturation level (Robba et al., 2020; Ahmed et al., 20204). RTs help manage airways, provide oxygen, help optimize ventilator settings, and run pulmonary rehab. Physiotherapists can help by doing breathing exercises, chest physio and coughing techniques and early mobilization programmers that help to improve respiratory function and recovery (Jain & Waseem, 2026; Jain & Waseem, 2025; De Moya et al., 2022). Good communication between these professions helps to prevent protocols being delayed, ensure protocol compliance and patient safety. Thus, multidisciplinary coordination is seen as essential to evidence-based trauma care, which is becoming more common (Muchnok et al., 2022; Yatera & Yamasaki, 2025; Al Tannir et al., 2024). Therefore, multidisciplinary collaboration is becoming a key element of evidence-based trauma care.

2.6 Research Gap

Although great advancements have been made in trauma care, there are gaps in knowledge of the prevention of PTP. Past studies often focus on interventions for individual preventive services, rather than multi-component prevention programs as part of a trauma care system (Bradley et al., 2020; Hemati & Agrawal, 2024; Jo, 2022). In addition, there are significant

differences between healthcare institutions in terms of implementation of guidelines, training of healthcare staff, adherence to guidelines and resource availability, which results in variability in clinical practice (Shi et al., 2024; Taran et al., 2023). A second critical point that was found in the literature was that information regarding the effectiveness of preventive protocols in thoracic trauma patients was lacking, overall, from previous studies (Réa-Neto et al., 2023; Chen et al., 2021; Ramsuchit et al., 2026). The benefits of early mobilization, physiotherapy or ventilator care have been studied individually in a few studies, but few studies have investigated whether these factors can be used together to minimize pneumonia (Lagazzi et al., 2024; Vasquez et al., 2020; Schieren et al., 2020). Furthermore, there are only a few studies that have compared the effect of various thoracic injury patterns on the occurrence of pneumonia, considering early detection and multidisciplinary intervention. In this regard, the present study aims to review existing preventive approaches, to list the most important physiological and clinical risk factors, to assess the significance of early detection and prompt treatment and to evaluate the effect of various chest trauma injuries on post-traumatic pneumonia in patients who receive treatment for thoracic trauma (Beeton et al., 2023; Deloney et al., 2021; Prins et al., 2021). This holistic approach offers proof that can help healthcare facilities enhance their pneumonia prevention policies for the trauma setting and improve patient outcomes.

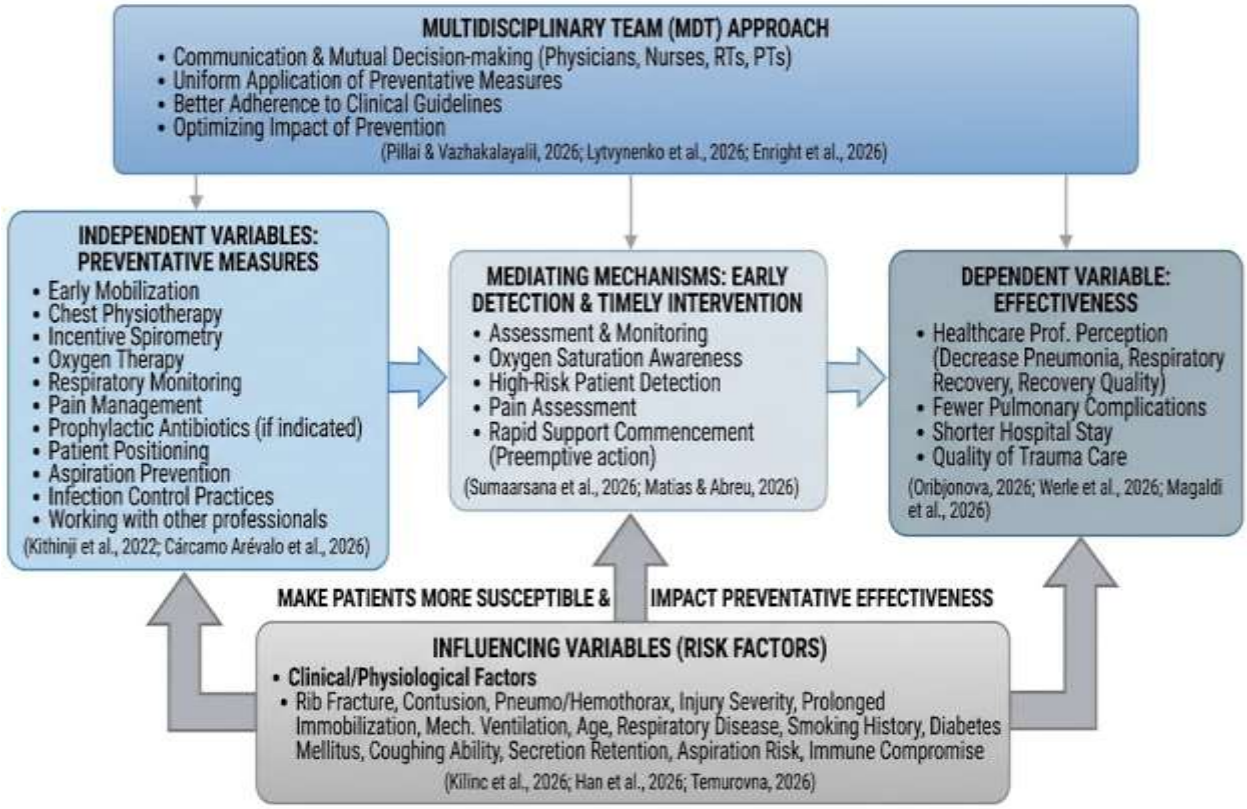
3. Conceptual Framework

This study assumes that evidence-based protocols for prevention of post-traumatic pneumonia need to be implemented in a successful way along the entire pathway of trauma care (Coccolini et al., 2024; Mahmood et al., 2020). The conceptual framework suggests that patient's physiological and clinical risk factors can be raised, as is the risk of pneumonia after thoracic trauma, however, timely preventive measures and multidisciplinary clinical management of these patients can lower this risk and improve patient outcomes (Rossaint et al., 2023; Gour-Provencal et al., 2021; Zhao et al., 2025). This framework has been designed directly from the thesis' study aims and research questions. The independent variables are the following preventative measures which are usually practiced in trauma care centers. These include early mobilization, chest physiotherapy, incentive spirometry, oxygen therapy, respiratory monitoring, pain management, administration of prophylactic antibiotics if indicated, patient positioning, pulmonary hygiene, aspiration prevention, infection control practices and working with other healthcare professionals (Kithinji et al., 2022; Cárcamo Arévalo et al., 2026). In this study, these interventions were identified as the main preventive interventions that are likely to reduce the pulmonary complications following thoracic trauma.

The Dependent variable is effectiveness of post-traumatic pneumonia prevention, which is assessed by the perception of the health care professionals about the decrease in pneumonia occurrence, better recovery from the respiratory system, quality of patient recovery, shorter hospital stay, fewer pulmonary complications, and better quality of trauma care (Oribjonova, 2026; Werle et al., 2026; Magaldi et al., 2026). These outcome indicators are general measures of the overall effectiveness of preventive measures in routine clinical practice. In the framework, several factors are influencing variables, such as clinical and physiological. These include rib fracture, pulmonary contusion, pneumothorax, hemothorax, severity of chest injury, prolonged immobilization, mechanical ventilation, advanced age, chronic respiratory disease, smoking history, diabetes mellitus, impaired coughing ability, secretion retention, aspiration risk, and compromised immune function (Kilinc et al., 2026; Han et al., 2026; Temurovna, 2026). All these factors make patients more susceptible to pneumonia and thus impact the ability of prevention measures to be effective.

The framework also acknowledges early detection and timely intervention as the mediating mechanisms. Respiratory assessment and monitoring, awareness of oxygen saturation, early detection of high-risk patients, early assessment of pain and rapid commencement of respiratory support enable preemptive action to be taken before the onset of pulmonary infection (Sumaarsana et al.,2026; Matias & Abreu, 2026). Early intervention helps build the connection between preventive protocols and better clinical outcomes. The framework emphasizes the importance of the multidisciplinary approach. Communication and mutual decision-making among physicians, nurses, respiratory therapists, physiotherapists and other healthcare professionals help to ensure uniform application of preventative measures and better adherence to clinical guidelines. This team-based approach should help to optimize the impact of pneumonia prevention measures in trauma care (Pillai & Vazhakalayalil, 2026; Lytvynenko et al., 2026; Enright et al., 2026).

Figure 1: Conceptual Framework



4. Research Methodology

4.1 Research Design

This study was quantitative research with a cross-sectional survey design to assess the effectiveness of preventive treatment for post traumatic pneumonia in the patients who suffered thoracic trauma. It was decided that a quantitative approach would be used as it would allow the systematic collection of numerical data and the use of statistical analysis to identify patterns, relationships and associations between preventive interventions and clinical outcomes (Enright et al., 2026; Ruiz et al., 2026; Rezaei et al., 2026). The cross-sectional design was deemed suitable as data was gathered from healthcare staff at one point in time to give an overview of the current preventative practice that is being utilized in trauma care settings. This study did not measure patient outcomes but rather assessed the views of healthcare professionals on whether evidence-based preventive protocols were effective or not. This design allowed for the evaluation of several preventive interventions at one time and the role of physiological and clinical risk factors, early detection, and the multidisciplinary approach on the prevention of post-traumatic pneumonia (Sobrinho & da Costa, 2026). Moreover, the quantitative approach enabled the application of inferential statistical techniques and objectively answered the research questions, significant relationship among the study variables.

4.2 Study Setting

The study was carried out in selected hospitals and health care institutions that are responsible for the treatment of thoracic trauma. Some of these institutions had trauma centers that were used routinely for patients with chest trauma, and preventive strategies implemented to minimize post traumatic pneumonia (Kurt et al., 2026; Bayraktar et al., 2026). The study focused on the adult trauma care services and excluded the pediatric setting and health care facilities not routinely caring for patients with thoracic trauma. The selected healthcare settings provided settings where doctors, nurses, respiratory therapists, physiotherapists and other healthcare workers were actively involved in pulmonary assessment, trauma management, pulmonary rehabilitation, and pneumonia prevention. Their hands-on experience gave them information on implementing and effectiveness of preventive protocols in their daily clinical experience (Chen et al., 2026; Patil et al., 2026; Alharran et al., 2026).

4.3 Population and Sampling

The target population included healthcare professionals who are involved in the management of patients with thoracic trauma. Physicians, nurses, respiratory therapists, physiotherapists and other healthcare workers directly involved in the implementation of prevention measures for the development of post-traumatic pneumonia were involved (Djanie et al., 2026; Portaccio et al.,

2026). The professionals were chosen due to their first-hand experiences in respiratory assessment, patient monitoring, pulmonary rehabilitation, infection prevention and multidisciplinary care of patients with trauma. The total number of participants in the study was 200 health care workers. The sample included professionals from a diversity of professional disciplines to provide as broad a base as possible for assessment of preventive practices on all trauma care teams (Zhang et al., 2024; Ayed et al., 2025). Representing multiple health care professions added diversity of clinical perspectives and increased generalizability of findings from the study in participating institutions.

4.4 Data Collection Instrument

A structured questionnaire, specially designed to evaluate preventive protocols for post-traumatic pneumonia, was the tool used to collect data. The questionnaire covered different aspects regarding preventive practice, demographic characteristics, early detection, collaboration with different disciplines, perceived effectiveness of preventive interventions, and physiological and clinical risk factors (Ayed et al., 2025; Oribjonov, 2026; Lodhia et al., 2023). All the responses were obtained based on standardized rating scales for uniformity and quantitative statistical analysis. Permission from institutions were obtained and the questionnaire was sent to healthcare professionals in trauma care facilities. The participants filled out the questionnaire voluntarily and the responses were anonymous, which helped to ensure accurate reporting and reduce response bias. The uniform format allowed for the comparability of responses being read and heard among various professional groups (Hofman et al., 2020; Howroyd et al., 2026; Vasse et al., 2023).

4.5 Reliability and Validity

The structured questionnaire was created based on literature review on trauma management and preventive protocols and was used to gather primary data. There were two sections of the questionnaire. The first part collected the demographic data on the participants such as their professional position, number of years of clinical experience, department and educational qualifications (Dogrul et al., 2020; El-Faramawy et al., 2020). The second section asked respondents what they thought of the effectiveness of evidence-based preventative interventions on a 5-point Likert scale, from 1 (Strongly Disagree) to 5 (Strongly Agree). Items on the questionnaire evaluated main constructs: early mobilization, chest physiotherapy, pain management, pulmonary hygiene, infection prevention, respiratory monitoring, oxygen therapy, multidisciplinary collaboration and overall prevention of post-traumatic pneumonia (Coccolini et al., 2025; Dote et al., 2020; Cakmak et al., 2022).

4.6 Reliability and Validity

Reliability and validity of the research instrument were conducted prior to the main data collection to ensure the quality of the research instrument. The questionnaire was subjected to evaluation by experts, and the content validity was established by making sure that all the elements of the questionnaire covered the study goals and the research questions (Freeman et al., 2022; Caputo et al., 2024). A pilot test was used before broad testing to clarify, make relevant and comprehensible the items on the questionnaires. One of the most widely accepted indicators for the reliability of a scale in quantitative research is known as internal consistency reliability which was measured using Cronbach's Alpha. The collected data was then analyzed using appropriate statistical procedures to test the consistency and reliability of the data. These procedures ensured reliable results from the measurement instrument to be suitable for inferential statistical analysis (Kumar et al., 2020; Elnahla et al., 2021).

4.7 Data Analysis Techniques

The analyses of the collected data were carried out with the help of the Statistical Package for the Social Sciences (SPSS). For this purpose, descriptive as well as inferential statistical techniques were used to achieve the research objectives and research questions (Wu et al., 2024; van Aswegen, 2020; Lorenzo et al., 2026; Aswegen et al., 2020). Demographic characteristics and preventive practices were described using descriptive statistics and reliability analysis was used to test the internal consistency of the questionnaire. Inferential statistics included correlation analysis, multiple regression analysis and other appropriate statistics were used to assess the relationships among preventive protocols and post-traumatic pneumonia prevention (El-Senousy et al., 2020; Robba et al., 2020). These analytical methods allowed the identification of significant predictors, analysis of associations between variables and the evaluation of the effectiveness of preventive interventions applied in thoracic trauma care.

4.8 Ethical Considerations

Ethical standards were followed in conducting the study with human subjects. The participation was voluntary and all respondents were briefed on the purpose and objectives of the study prior to filling the questionnaire. Participants were free to withdraw at any time from the study or not participate at all without the need to endure any consequences (Ahmed et al., 2024; Jain & Waseem, 2026). The confidentiality and anonymity of the research participants were ensured during the research process. No personal information was gathered, and all data was only used for academic research. Participant privacy was

maintained by storing and analyzing data in a secure manner, using aggregate data (Jain & Waseem, 2025; De Moya et al., 2022; Muchnok et al., 2022). Permission from the institutions was sought in advance of data collection and the research was carried out in an ethical way in keeping with accepted standards for healthcare research.

5. Results

Table 1: Reliability Analysis

Construct/Scale	No. of Items	Cronbach's Alpha
Construct 1	17	0.972
Construct 2	9	0.947
Construct 3	4	0.892
Construct 4	3	0.853
Construct 5	3	0.851
Construct 6	2	0.765
Construct 7	3	0.868
Construct 8	4	0.890
Total Scale	45	0.972

The reliability analysis of the research instrument was carried out using Cronbach's alpha as shown in table 1. The results show good internal consistency across all constructs of this study between Cronbach's Alpha values of 0.765 to 0.972. Cronbach's Alpha was calculated for the overall questionnaire, and the result was 0.972, which indicated high reliability and the instrument was consistently measuring the constructs being investigated by the questionnaire (Yatera & Yamasaki, 2025; Al Tannir et al., 2024). The reliability of the constructs is shown to range from good to excellent with Construct 1 having the highest reliability (α = 0.972) and Construct 6 having the lowest reliability (α = 0.765) which is still above the acceptable level of 0.70. All Cronbach alpha value was more than the minimum value recommended so that the research instrument was suitable to be used in further statistical analysis such as correlation, regression and hypothesis testing (Bradley et al., 2020; Hemati et al., 2024).

Table 2: Correlation Analysis

Correlations		Perceived Effectiveness of Post-Traumatic Pneumonia Prevention Protocols	Clinical Prevention Practices	Patient Assessment and Monitoring	Care Coordination and Rehabilitation	Education and Compliance Management	Effectiveness of Pneumonia Prevention Strategies	Challenges and Barriers	Training Collaboration and Future Improvements
Perceived Effectiveness of Post-Traumatic Pneumonia Prevention Protocols	Pearson Correlation	1	.940**	.927**	.905**	.897**	.874**	.900**	.918**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000
	N	200	200	200	200	200	200	200	200
Clinical Prevention Practices	Pearson Correlation	.940**	1	.924**	.916**	.912**	.868**	.919**	.914**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000
	N	200	200	200	200	200	200	200	200

Patient Assessment and Monitoring	Pearson Correlation	.927**	.924**	1	.874**	.886**	.851**	.877**	.894**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000
	N	200	200	200	200	200	200	200	200
Care Coordination and Rehabilitation	Pearson Correlation	.905**	.916**	.874**	1	.881**	.840**	.879**	.877**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000
	N	200	200	200	200	200	200	200	200
Education and Compliance Management	Pearson Correlation	.897**	.912**	.886**	.881**	1	.842**	.892**	.870**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000
	N	200	200	200	200	200	200	200	200
Effectiveness of Pneumonia Prevention Strategies	Pearson Correlation	.874**	.868**	.851**	.840**	.842**	1	.826**	.852**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000
	N	200	200	200	200	200	200	200	200
Challenges and Barriers	Pearson Correlation	.900**	.919**	.877**	.879**	.892**	.826**	1	.874**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000
	N	200	200	200	200	200	200	200	200
Training Collaboration and Future Improvements	Pearson Correlation	.918**	.914**	.894**	.877**	.870**	.852**	.874**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	
	N	200	200	200	200	200	200	200	200

**. Correlation is significant at the 0.01 level (2-tailed).

The Pearson correlation coefficients are reported in Table 2. The results show that there are strong and significant positive relationships between perceived effectiveness of the post-traumatic pneumonia prevention protocols and all independent variables ($p < 0.001$). Clinician Assessment and Monitoring ($r = 0.940$), Patient Assessment and Monitoring ($r = 0.927$), and Training, Collaboration and Future Improvements ($r = 0.918$) had the highest positive correlation with the dependent variable (Jo, 2022; Shi et al., 2024). The remaining strong positive correlations were with Care Coordination and Rehabilitation ($r = 0.905$), Challenges and Barriers ($r = 0.900$), and Education and Compliance Management ($r = 0.897$), and Effectiveness of Pneumonia Prevention Strategies ($r = 0.874$). The results suggest that better clinical preventive practices, patient surveillance, multidisciplinary cooperation, and ongoing professional education are linked to better effectiveness of post-traumatic pneumonia prevention protocols (Taran et al., 2023; Réa-Neto et al., 2023; Chen et al., 2021). In general, the correlation analysis shows that all the variables in the study are significantly and positively correlated with the dependent variable.

Table 3: Multiple Regression Analysis

Predictor Variables	B	S.E.	t	p-value
Constant	0.157	0.060	2.592	0.010
Years of Experience in Healthcare Roles	0.034	0.030	1.137	0.257
Pneumonia Prevention Methods Used	0.101	0.027	3.685	<0.001
Role within Healthcare Team	0.031	0.039	0.798	0.426
Clinical Prevention Practices	0.248	0.109	2.280	0.024
Patient Assessment and Monitoring	0.294	0.080	3.668	<0.001
Care Coordination and Rehabilitation	0.176	0.071	2.472	0.014
Education and Compliance Management	0.014	0.072	0.189	0.850

Effectiveness of Pneumonia Prevention Strategies	0.136	0.057	2.399	0.017
Challenges and Barriers	0.098	0.072	1.348	0.179
Training, Collaboration and Future Improvements	0.236	0.076	3.109	0.002
Model Statistics	Value			
R	0.965			
R^2	0.932			
Adjusted R^2	0.928			
F(10,189)	258.705			
Model p-value	<0.001			
Std. Error of Estimate	0.246			

The findings of the multiple regression analysis of predictors of perceived effectiveness of post-traumatic pneumonia prevention protocols are shown in Table 3. The regression model was highly significant (F = 258.705, $p < 0.001$) and the $R^2 = 0.932$ and Adjusted $R^2 = 0.928$ showed an excellent fit with the model. Patient Assessment and Monitoring (B = 0.294, $p < 0.001$), Clinical Prevention Practices (B = 0.248, p = 0.024), Training, Collaboration and Future Improvements (B = 0.236, p = 0.002), Effectiveness of Pneumonia Prevention Strategies (B = 0.136, p = 0.017), and Pneumonia Prevention Methods Used (B = 0.101, $p < 0.001$) were the strongest predictors (Ramsuchit et al., 2026; Lagazzi et al., 2024; Vasquez et al., 2020). Years of Experience, Role within the Healthcare Team, Education and Compliance Management and Challenges and Barriers were not statistically significant ($p > 0.05$). The study results suggest that a better understanding of the patient, appropriate clinical practice, cooperation between the medical specialists and ongoing professional training are critical to maximizing the effectiveness of post-traumatic pneumonia prevention programs (Schieren et al., 2020; Beeton et al., 2023).

Table 4: Descriptive Statistics

Descriptive Statistics	N	Minimum	Maximum	Mean	Std. Deviation
Perceived Effectiveness of Post-Traumatic Pneumonia Prevention Protocols	200	1.00	5.00	3.0529	.92029
Clinical Prevention Practices	200	1.00	3.00	2.0417	.62621
Patient Assessment and Monitoring	200	1.00	3.00	2.0050	.64043
Care Coordination and Rehabilitation	200	1.00	3.00	2.0067	.66243
Education and Compliance Management	200	1.00	3.00	2.0183	.67845
Effectiveness of Pneumonia Prevention Strategies	200	1.00	3.00	2.0100	.67429
Challenges and Barriers	200	1.00	3.00	2.0033	.67083
Training Collaboration and Future Improvements	200	1.00	3.00	2.0100	.64282
Valid N (listwise)	200				

Descriptive statistics for all the study variables are presented in Table 4. PTPP perceived effectiveness mean score was 3.05 (SD = 0.92), noting a generally positive perception of PTPPs by HCPs. The remaining constructs were seen to have a consistent mean value between 2.00 and 2.04, indicating perceptions to be consistently similar across clinical prevention practices, patient assessment and monitoring, care coordination and rehabilitation, education and compliance management, effectiveness of pneumonia prevention strategies, challenges and barriers, and training, collaboration, and future improvements (Deloney et al., 2021; Prins et al., 2021; Coccolini et al., 2024). The relatively small standard deviation values show consistency in the responses of participants, and that minimum and maximum values were observed means that the participants used the entire range of the

measurement scale (Mahmood et al., 2020; Rossaint et al., 2023; Gour-Provencal et al., 2021). In general, descriptive statistics indicated a positive perception of healthcare professionals when it comes to implementation of preventive protocols in thoracic trauma care.

Table 5: Perceived Effectiveness of Post-Traumatic Pneumonia Prevention Protocols According to Work Experience

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 to 3 years	22	1.7219	.46784	.09974	1.5145	1.9294	1.00	2.65
3 to 5 years	40	2.3941	.45177	.07143	2.2496	2.5386	1.18	3.24
5 to 10 years	63	2.9524	.47176	.05944	2.8336	3.0712	1.88	4.47
Less than 1 year	54	3.6231	.58685	.07986	3.4629	3.7833	2.47	4.76
More than 10 years	21	4.5378	.39385	.08594	4.3585	4.7171	3.65	5.00
Total	200	3.0529	.92029	.06507	2.9246	3.1813	1.00	5.00

Table 5 shows how effective participants feel the post-traumatic pneumonia prevention protocols are, according to their experiences in various categories of health care work. The results indicate that mean scores gradually increased as professional experience increased. The respondents who had experience of more than 10 years in the field reported the highest perceived effectiveness (Mean = 4.54) while the respondents who had experience of 1-3 years had the lowest mean score (Mean = 1.72). Healthcare workers who have less than 1 year of experience, 3–5 years, and 5–10 years of experience reported mean scores of 3.62, 2.39, and 2.95, respectively (Zhao et al., 2025; Kithinji et al., 2022). The results indicated that the more experience a doctor had with pneumonia, the more likely they were to feel confident about and value pneumonia prevention measures. The relatively narrow confidence intervals and low standard errors also suggest stable and reliable estimated group means (Cárcamo Arévalo et al., 2026; Oribjonova, 2026; Werle et al., 2026).

Table 6: ANOVA Analysis

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	120.830	4	30.208	123.465	.000
Within Groups	47.710	195	.245		
Total	168.540	199			

The result of one-way Analysis of Variance (ANOVA) was shown in Table 6 to examine the differences between the groups of healthcare professionals in terms of their perceived effectiveness of the post-traumatic pneumonia prevention protocols based on their number of years worked. There was a statistically significant difference between experience groups ($F(4,195) = 123.465$, $p < 0.001$). This finding suggests that there is a wide range of attitudes among healthcare workers about how successful pneumonia prevention measures are (Magaldi et al., 2026; Kilinc et al., 2026). Thus, the null hypothesis, which was that there was no difference among the experience groups, is rejected. The results also indicate that more professional experiences is associated with a more positive attitude toward preventive strategies for post-traumatic pneumonia among healthcare professionals (Han et al., 2026; Temurovna, 2026; Sumaarsana et al., 2026).

Figure 2: Distribution of Respondents by Years of Experience in Healthcare Roles

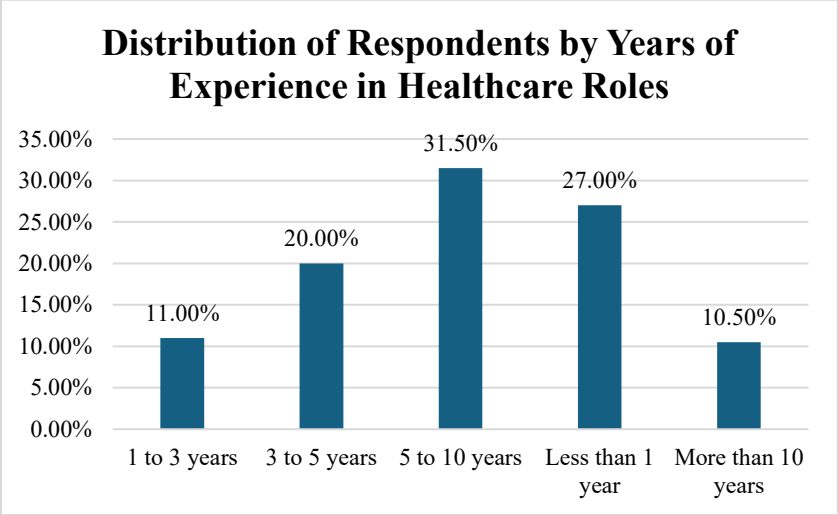
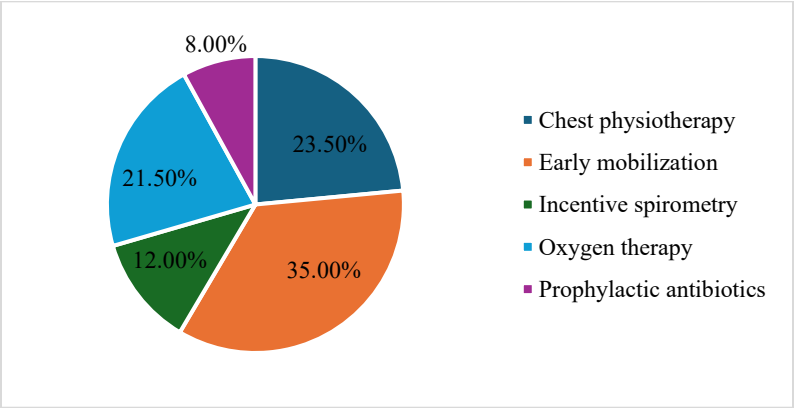


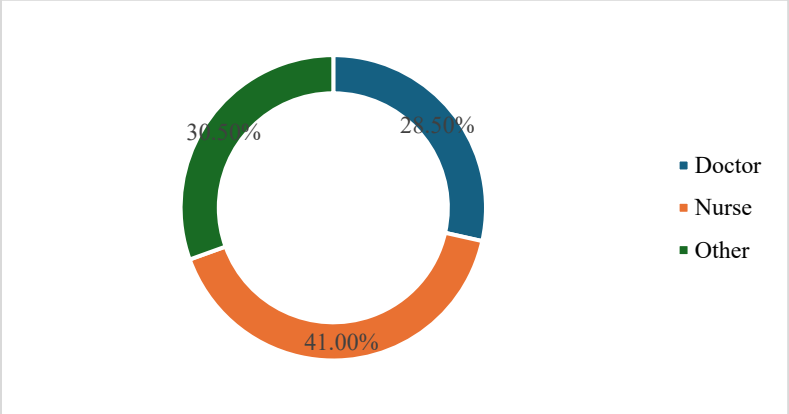
Figure 2 shows the frequency distribution of the respondents by years' experience in healthcare. The highest number of participants came with 5–10 years of experience (31.5%) followed by 27.0% with less than a year. 20.0% of respondents had 3–5 years of experience and 11.0% had 1–3 years of experience (Matias & Abreu, 2026). More than 10 years of experience in their healthcare field was the smallest group (10.5%). In terms of extent of professional experience, the distribution of the study participants is a reflection of the fact that those cared for were not a homogeneous group, thus offering a good cross-section for the assessment of factors affecting the success of post-traumatic pneumonia prevention protocols (Pillai et al., 2026; Lytvynenko et al., 2026; Enright et al., 2026).

Figure 3: Distribution of Pneumonia Prevention Methods Used in Trauma Care



The most used measures for the prevention of pneumonia in trauma care are presented in figure 2. The most common method was early mobilization (35.0%) which was widely used by healthcare professionals (Ruiz et al., 2026; Rezaei et al., 2026). Chest physiotherapy (23.5%) and Oxygen therapy (21.5%) were the next most common therapies, both of which are also crucial prevention steps for pneumonia. Incentive spirometry was the most common method used (12.0%) and Prophylactic antibiotics was the least used method (8.0%) (Sobrinho & da Costa, 2026; Kurt et al., 2026; Bayraktar et al., 2026). The results of these analyses indicate that non-pharmacological preventive interventions are employed more often than antibiotic prophylaxis, which are consistent with recent clinical practice in post-traumatic pneumonia prevention.

Figure 4: Distribution of Respondents by Role within the Healthcare Team



The respondents who formed part of this study had a range of professional roles as represented in Figure 3. Other healthcare workers (30.5%) were the second largest group, followed by nurses (41.0%) and Doctors (28.5%). This is due to the fact that doctors and other healthcare professionals participate in the study, capturing multi-disciplinary perspectives, and the increased proportion of nurses is reflective of their pivotal role in the implementation of post traumatic pneumonia prevention protocols on a day-to-day basis (Chen et al., 2026; Patil et al., 2026; Alharran et al., 2026). This is a diverse professional representation that adds to the credibility of the conclusions of the study on pneumonia prevention practices.

6. Discussion

The current study aimed to assess the efficiency of the preventive measures of post-traumatic pneumonia (PTP) in thoracic trauma patients from healthcare professionals' viewpoint. The results show that evidence-based preventive protocols are very effective if applied in a structured multidisciplinary approach (Djanie et al., 2026; Portaccio et al., 2026). The perceived effectiveness of PTP prevention protocols were strongly correlated with all major preventive domains (clinical prevention practices, patient assessment and monitoring, care coordination and rehabilitation, education and compliance management, training and future improvements) (Zhang et al., 2024; Ayed et al., 2025; Oribjonov, 2026). These results suggest that preventive approaches with a wide scope have significant impacts on respiratory outcomes and the risk of pulmonary complications. The multiple regression analysis also showed that, besides clinical prevention practices, patient assessment and monitoring, multidisciplinary collaboration, rehabilitation and evidence-based pneumonia prevention practices were the most significant predictors of effective pneumonia prevention (Lodhia et al., 2023; Hofman et al., 2020; Howroyd et al., 2026). These findings highlight the need for timely clinical management after thoracic trauma to prevent post-traumatic pneumonia, early identification of patients who are at risk, and ongoing monitoring of the respiratory function (Vasse et al., 2023; Dogrul et al., 2020). Additionally, the results indicate that when treatment is centralized and provided in a multidisciplinary manner, preventive protocols are more effective and better implemented.

The descriptive analysis revealed mostly positive attitudes towards preventive protocols implementation among healthcare workers (El-Faramawy et al., 2020; Coccolini et al., 2025; Dote et al., 2020). Additionally, there were substantial differences by experience level, with more experienced healthcare providers having more confidence in preventive measures and clinical decision making (Cakmak et al., 2022; Freeman et al., 2022; Caputo et al., 2024). The results emphasize the need for ongoing professional learning and formal training to enhance protocol compliance by less experienced health care practitioners. The results are consistent with the incorporation of early mobilization, chest physiotherapy, proper pain control, pulmonary hygiene, oxygenation, respiratory monitoring, and multidisciplinary care into standardized trauma care pathways (Kumar et al., 2020; Elnahla et al., 2021; Wu et al., 2024). The consistent application of those interventions may lead to a decrease in the incidence of pneumonia after thoracic trauma, shorten hospital stays, lower medical costs, and better patient outcomes.

7. Practical Implications

The study underscores the importance of implementing uniform preventative measures in the care of thoracic trauma patients. These principles of routine respiratory assessment, early mobilization, chest physiotherapy, effective pain management and multidisciplinary teamwork should be implemented in daily clinical practice. Ongoing staff education could also help ensure compliance with these guidelines and provide better care for patients (van Aswegen, 2020; Lorenzo et al., 2026; Aswegen et al., 2020).

8. Conclusion

This research shows that post-traumatic pneumonia is a highly preventable complication with the use of evidence-based preventive protocols when patients have thoracic trauma. The results indicate that the effectiveness of strategies to prevent pneumonia is greatly enhanced by undertaking patient assessment and monitoring, by implementing clinical prevention practices, by working in a multidisciplinary team, by conducting rehabilitation, and by continuing to train health care professionals. The study also highlights the need for a coordinated multidisciplinary approach for successful prevention of which early mobilization, respiratory monitoring, chest physiotherapy, pulmonary hygiene, oxygen therapy, infection prevention and effective pain management are all critical. Making these preventive interventions a standard in trauma care settings could make a significant contribution towards patient recovery, lower the risk of respiratory complications, and increase the quality of trauma care.

9. Limitations

There were some limitations in this study. First, it was of a cross sectional design, the main limitation of which is that it does not allow for causal interpretation. Secondly, the results were subjective and based on the perceptions of healthcare professionals rather than on actual patient outcomes. Last but not least, the study took place in selected healthcare institutions that may restrict the generalizability of the findings.

10.Future Research

Multimarket and longitudinal investigations should be conducted in the future, to assess the sustained impact of preventive protocols. Other clinical outcomes like pneumonia incidence, length of hospital stay, and need for intensive care should be included in research to enhance evidence of preventive strategies..

References

1. Ahmed, S. A., Abdulqader, S. K., & Shakir, N. A. (2024). The efficacy of bedside chest ultrasound in the detection of traumatic pneumothorax. The Open Neuroimaging Journal, 17(1).
2. Al Tannir, A. H., Biesboer, E. A., Golestani, S., Tentis, M., Maring, M., Gellings, J., ... & Carver, T. W. (2024). Thoracic cavity irrigation prevents retained hemothorax and decreases surgical intervention in trauma patients. Journal of Trauma and Acute Care Surgery, 97(1), 90-95.
3. Alharran, A. M., Almutawtah, S., Alblooshi, S. S., Alsaid, F. A., Alajmi, M. S., AlRumaihi, M. J., & Albuhmaid, S. A. (2026). Efficacy and Safety of Serratus Anterior Plane Block for Pain Management in Patients with Rib Fractures: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Medicina, 62(2), 281.
4. Aswegen, H. V., Reeve, J., Beach, L., Parker, R., & Olsèn, M. F. (2020). Physiotherapy management of patients with major chest trauma: results from a global survey. Trauma, 22(2), 133-141.
5. Ayed, A. S., Al Dawsri, A. S. M., Alshrudh, M. A. M., Rajhi, M. A. A., Alatawi, T. A. S., Aldosari, A. A. A., ... & Alarashidi, K. A. O. (2025). Comprehensive Multidisciplinary Management of Postoperative Thoracic Surgery Patients: Imaging Assessment, Intraoperative Support, Respiratory Care, and Early Rehabilitation. Saudi Journal of Medicine and Public Health, 2(2), 3292-3302.
6. Bayraktar, Y. Ş., Şahinoğlu, T., Cebeci, Y., Güngör, D. C., Pekince, B., Körez, M. K., ... & Çelik, J. B. (2026). Factors Affecting Mortality and Clinical Outcomes in Intensive Care Unit Patients with Thoracic Trauma: A Retrospective, Single-Center Study. Medicina, 62(2), 294.
7. Beeton, G., Ngatuvai, M., Breeding, T., Andrade, R., Zagales, R., Khan, A., ... & Elkbuli, A. (2023). Outcomes of pigtail catheter placement versus chest tube placement in adult thoracic trauma patients: a systematic review and meta-analysis. The American Surgeon™, 89(6), 2743-2754.
8. Bradley, M., Dente, C., Khatri, V., Schobel, S., Lisboa, F., Shi, A., ... & Elster, E. (2020). Advanced modeling to predict pneumonia in combat trauma patients. World journal of surgery, 44(7), 2255-2262.
9. Cakmak, G., Cansun, F., Saracoglu, A., & Saracoglu, K. T. (2022). Airway management in penetrating thoracic trauma. Anaesthesiology Intensive Therapy, 54(3), 253-261.\
10. Caputo, G., Meda, S., Piccioni, A., Saviano, A., Ojetti, V., Savioli, G., ... & La Russa, R. (2024). Thoracic trauma: current approach in emergency medicine. Clinics and Practice, 14(5), 1869-1885.
11. Cárcamo Arévalo, M. D., Margarita Arias, M., Franco Cardona, S., Atshan, A., Gómez Ballesta, F. J., & Alzate Granado, J. P. (2026). Effectiveness of damage control interventions in blunt thoracic trauma: A systematic review. Surgical Chronicles, 31(1), 20.

12. Chen, J., Chen, F., Su, Q., Shao, M., Wang, Y., & Gao, Y. (2026). Prevalence and associated risk factors of pneumonia following surgery for geriatric osteoporotic fracture: A nationwide cross-sectional study of China. Scientific Reports.
13. Chen, J., Tsur, A. M., Nadler, R., Ner, E. B., Sorkin, A., Radomislensky, I., ... & Benov, A. (2021). Ten-year reduction in thoracic injury-related mortality among Israel Defense Forces soldiers. BMJ Mil Health.
14. Coccolini, F., Cremonini, C., Moore, E. E., Civil, I., Balogh, Z., Leppaniemi, A., ... & Coimbra, R. (2025). Thoracic trauma WSES-AAST guidelines. World Journal of Emergency Surgery, 20(1), 78.
15. Coccolini, F., Sartelli, M., Sawyer, R., Rasa, K., Ceresoli, M., Viaggi, B., ... & Coimbra, R. (2024). Antibiotic prophylaxis in trauma: Global Alliance for Infection in Surgery, surgical infection society Europe, world surgical infection society, American association for the surgery of trauma, and world society of emergency surgery guidelines. Journal of Trauma and Acute Care Surgery, 96(4), 674-682.
16. De Moya, M., Brasel, K. J., Brown, C. V., Hartwell, J. L., Inaba, K., Ley, E. J., ... & Martin, M. J. (2022). Evaluation and management of traumatic pneumothorax: a Western Trauma Association critical decisions algorithm. Journal of Trauma and Acute Care Surgery, 92(1), 103-107.
17. Deloney, L. P., Smith Condeni, M., Carter, C., Privette, A., Leon, S., & Eriksson, E. A. (2021). Efficacy of methocarbamol for acute pain management in young adults with traumatic rib fractures. Annals of Pharmacotherapy, 55(6), 705-710.
18. Djanie, T., Pfaff, A., Miller, C., Ata, A., Stolarski, A. E., Evans, L., ... & Tafen, M. (2026). Impact of a rib fracture treatment protocol: a propensity score matching analysis. Trauma Surgery & Acute Care Open, 11(3), e001989.
19. Dogrul, B. N., Kiliccalan, I., Asci, E. S., & Peker, S. C. (2020). Blunt trauma related chest wall and pulmonary injuries: An overview. Chinese journal of traumatology, 23(03), 125-138.
20. Dote, H., Homma, Y., Sakuraya, M., Funakoshi, H., Tanaka, S., & Atsumi, T. (2020). Incentive spirometry to prevent pulmonary complications after chest trauma: a retrospective observational study. Acute Medicine & Surgery, 7(1), e619.
21. El-Faramawy, A., Jabbour, G., Afifi, I., Abdelrahman, H., Qabbani, A. S., Al Nobani, M., ... & El-Menyar, A. (2020). Complications following chest tube insertion pre-and post-implementation of guidelines in patients with chest trauma: A retrospective, observational study. International Journal of Critical Illness and Injury Science, 10(4), 189-194.
22. Elnahla, A., Iuliucci, K. R., Toraih, E., Duchesne, J. C., Nichols, R. L., & Kandil, E. (2021). The efficacy of the use of presumptive antibiotics in tube thoracostomy in thoracic trauma-results of a meta-analysis. The American Journal of Surgery, 222(5), 1017-1022.
23. El-Senousy, T., Mahrous, F. M., Abd-Al Salam, S. N., & Zedan, H. I. (2020). Educational Guidelines for Nurses' Competence Level Caring for Patients with Accidental Chest Trauma during Emergency Period. Systematic Reviews in Pharmacy, 11(12).
24. Enright, D., Murphy, O., Doran, J., Rice, D., Bartolozzi, F., Kelly, R., ... & Hanley, C. (2026). Thoracic trauma in intensive care: A ten-year retrospective cohort study from a regional trauma unit. Trauma, 28(2-3), 120-130.
25. Freeman, J. J., Asfaw, S. H., Vatsaas, C. J., Yorkgitis, B. K., Haines, K. L., Burns, J. B., ... & Kasotakis, G. (2022). Antibiotic prophylaxis for tube thoracostomy placement in trauma: a practice management guideline from the Eastern Association for the Surgery of Trauma. Trauma Surgery & Acute Care Open, 7(1).
26. Gour-Provencal, G., Mac-Thiong, J. M., Feldman, D. E., Bégin, J., & Richard-Denis, A. (2021). Decreasing pressure injuries and acute care length of stay in patients with acute traumatic spinal cord injury. The Journal of Spinal Cord Medicine, 44(6), 949-957.
27. Han, X., Chi, W., Pang, P., Liu, X., Luo, Z., Cai, W., ... & Hao, J. (2026). A clinically useful nomogram integrating bedside lung ultrasound and clinical parameters for pulmonary complications after non-thoracic surgery in blunt chest trauma patients. Frontiers in Medicine, 13, 1804376.
28. Hemati, K., Gray, A. T., & Agrawal, A. (2024). A comprehensive review of the non-operative management of traumatic rib fractures. Current Anesthesiology Reports, 14(4), 567-575.
29. Hofman, M., Andruszkow, H., Kobbe, P., Poeze, M., & Hildebrand, F. (2020). Incidence of post-traumatic pneumonia in poly-traumatized patients: identifying the role of traumatic brain injury and chest trauma. European journal of trauma and emergency surgery, 46(1), 11-19.
30. Howroyd, F., Weblin, J., Smith, F. G., Duggal, N. A., & Ahmed, Z. (2026). The impact of traumatic injury on the respiratory system; a narrative review of injury-associated and clinically-induced mechanisms of trauma-associated pneumonia. Frontiers in Medicine, 13, 1807707.
31. Jain, A., & Waseem, M. (2025). Chest trauma. In StatPearls [Internet]. StatPearls Publishing.
32. Jain, A., & Waseem, M. (2026). Thoracic Trauma. In StatPearls [Internet]. StatPearls Publishing.
33. Jo, K. W. (2022). Target temperature management in traumatic brain injury with a focus on adverse events, recognition, and prevention. Acute and Critical Care, 37(4), 483-490.
34. Kilinc, S., Aydogan, M. S., Duran, M., & Yucetas, C. S. (2026). Incidence, microbiology, and clinical impact of ventilator-associated pneumonia in traumatic brain injury: a single-center retrospective study. Brain Injury, 40(7), 614-618.

35. Kithinji, S. M., Lule, H., Acan, M., Kyomukama, L., Muhumuza, J., & Kyamanywa, P. (2022). Efficacy of extended focused assessment with sonography for trauma using a portable handheld device for detecting hemothorax in a low resource setting; a multicenter longitudinal study. BMC Medical Imaging, 22(1), 211.
36. Kumar, R. G., Kesinger, M. R., Juengst, S. B., Brooks, M. M., Fabio, A., Dams-O'Connor, K., ... & Wagner, A. K. (2020). Effects of hospital-acquired pneumonia on long-term recovery and hospital resource utilization following moderate to severe traumatic brain injury. Journal of Trauma and Acute Care Surgery, 88(4), 491-500.
37. Kurt, O. K., Kayalar, O., Yildiz, A. B., Shahpar, Z., Annesi-Maesano, I., & Bayram, H. (2026). Respiratory impacts of earthquakes. European Respiratory Review, 35(180), 250257.
38. Lagazzi, E., Rafaqat, W., Argandykov, D., de Roulet, A., Abiad, M., Proaño-Zamudio, J. A., ... & Albutt, K. H. (2024). Timing matters: early versus late rib fixation in patients with multiple rib fractures and pulmonary contusion. Surgery, 175(2), 529-535.
39. Lodhia, J. V., Eyre, L., Smith, M., Toth, L., Troxler, M., & Milton, R. S. (2023). Management of thoracic trauma. Anaesthesia, 78(2), 225-235.
40. Lorenzo, M., Coimbra, R., Croft, C. A., Hartwell, J. L., Schuster, K. S., Moore, E. E., ... & Stein, D. M. (2026). Western Trauma Association critical decisions in trauma: Penetrating thoracic injury. Journal of Trauma and Acute Care Surgery, 100(3), 484-492.
41. Lytvynenko, I., Petrov, S. H., Mladenov, M. E., & Sopotensky, S. (2026). Tree branch penetrating chest trauma: clinical case report and retrospective study. Acta Medica Bulgarica, 53(Suppl 1), 88-92.
42. Magaldi, G. P., Kruger, V. F., Magaldi, H. H., Hirano, E. S., Leandro-Merhi, V. A., & de Aquino, J. L. B. (2026). Fast, accurate, and cost-effective: E-FAST's breakthrough in optimizing thoracic trauma management. Turkish J Surg, 42(1), 108.
43. Mahmood, I., Younis, B., Ahmed, K., Mustafa, F., El-Menyar, A., Alabdallat, M., ... & Al-Thani, H. (2020). Occult pneumothorax in patients presenting with blunt chest trauma: an observational analysis. Qatar Medical Journal, 2020(1), 10.
44. Matias, J., & Abreu, J. M. (2026). Point-of-Care Ultrasound in Blunt Chest Trauma: Diagnostic Performance and Clinical Relevance. Cureus, 18(3), e105427.
45. Mohamed Adam, S., Mustafa Ahmed, S., Elsayed Khatab, H., Ragab Soliman Gad, E., Saber Mohamed, S., & Hassan Mohamed, S. (2025). Effect of Implementing a Protocol-Driven Approach to Blunt Chest Trauma on Patients' Outcomes. Egyptian Journal of Health Care, 16(4), 1099-1108.
46. Muchnok, D., Vargo, A., Deeb, A. P., Guyette, F. X., & Brown, J. B. (2022). Association of prehospital needle decompression with mortality among injured patients requiring emergency chest decompression. JAMA surgery, 157(10), 934-940.
47. Nevzghoda, O., Nevzghoda, A., Rak, L., Zhykovskiy, V., & Ivaskevych, Y. (2024). Thoracic trauma: diagnosis and treatment. SSP Modern Pharmacy and Medicine, 4(3), 1-14.
48. Oribjonov, O. E. (2026). DIAGNOSTIC METHODS AND PREVENTIVE MEASURES OF NOSOCOMIAL PNEUMONIA IN PATIENTS WITH POLYTRAUMA. Журнал гуманитарных и естественных наук, (30), 43-49.
49. Oribjonova, H. A. (2026). Ventilator-Associated Pneumonia In Polytrauma Patients: Diagnostic Challenges And Prevention. Журнал гуманитарных и естественных наук, (30), 50-54.
50. Patil, A., Deshpande, M., Wasule, S. B., Reddy, D., Bhusare, D., Sinha, S., ... & Wasule Jr, S. B. (2026). An Investigation of the Etiology and Pattern of Spinal Injuries Among Patients Presenting to the Emergency Department in a Tertiary Care Hospital. Cureus, 18(7).
51. Pillai, S. R., Remanan, R., & Vazhakalayalil, V. G. (2026). Role of the Chest Trauma Scoring System as a Predictor of Mortality and Morbidity and as a Prognostic Tool in Thoracic Trauma Patients: A Prospective Observational Study. Amrita Journal of Medicine.
52. Portaccio, I., Genovese, O., De Leonardis, F., Vitali, I., Picconi, E., Morena, T. C., ... & Piastra, M. (2026). Efficacy of a Chlorhexidine-Based Oral Prevention Protocol in Reducing Ventilator-Associated Pneumonia in Pediatrics: A Controlled Before-After Study. Journal of Intensive Care Medicine, 08850666261440187.
53. Prins, J. T., Van Lieshout, E. M., Ali-Osman, F., Bauman, Z. M., Caragounis, E. C., Choi, J., ... & Wijffels, M. M. (2021). Outcome after surgical stabilization of rib fractures versus nonoperative treatment in patients with multiple rib fractures and moderate to severe traumatic brain injury (CWIS-TBI). Journal of Trauma and Acute Care Surgery, 90(3), 492-500.
54. Ramsuchit, B., Ugarte, S. M., Kao, L. S., & Meyer, D. (2026). A Contemporary Review of Operative Indications for Chest Wall Trauma. Thoracic Surgery Clinics, 36(2), 223-234.
55. Réa-Neto, Á., da Silva Júnior, E. D., Hassler, G., Dos Santos, V. B., Bernardelli, R. S., Kozesinski-Nakatani, A. C., ... & Teive, H. A. G. (2023). Epidemiological and clinical characteristics predictive of ICU mortality of patients with traumatic brain injury treated at a trauma referral hospital–a cohort study. BMC neurology, 23(1), 101.
56. Rezaei, M. R., Farnia, M. R., Tabrizi, S., Oskui, A. G., Shiravand, M., & Rezaei, B. (2026). Investigating the predictive power of clinical findings and examinations in the diagnosis of thorax bone fractures in patients with chest trauma; a retrospective cross-sectional study. Journal of Preventive Epidemiology, 11(1), 1.

57. Robba, C., Rebora, P., Banzato, E., Wiegers, E. J., Stocchetti, N., Menon, D. K., ... & Sandro, O. (2020). Incidence, risk factors, and effects on outcome of ventilator-associated pneumonia in patients with traumatic brain injury: analysis of a large, multicenter, prospective, observational longitudinal study. Chest, 158(6), 2292-2303.
58. Rossaint, R., Afshari, A., Bouillon, B., Cerny, V., Cimpoesu, D., Curry, N., ... & Spahn, D. R. (2023). The European guideline on management of major bleeding and coagulopathy following trauma. Critical care, 27(1), 80.
59. Ruiz, C., Aquevedo, A., Marambio-Coloma, C., Arqueros, L., Bugedo, G., & Damiani, L. F. (2026). Mechanical Ventilation in Trauma-Induced Respiratory Failure: A Clinical Review. Respiratory Care, 71(4), 405-416.
60. Schieren, M., Wappler, F., Klodt, D., Sakka, S. G., Lefering, R., Jäcker, V., & Defosse, J. (2020). Continuous lateral rotational therapy in thoracic trauma—A matched pair analysis. Injury, 51(1), 51-58.
61. Shi, Y., Hu, Y., Xu, G. M., & Ke, Y. (2024). Development and validation of a predictive model for pulmonary infection risk in patients with traumatic brain injury in the ICU: a retrospective cohort study based on MIMIC-IV. BMJ Open Respiratory Research, 11(1).
62. Sobrinho, J. L. C., & da Costa, R. I. D. (2026). with VATS (Video-Assisted Thoracoscopic Surgery). Minimally Invasive Surgery Trauma: Laparoscopic and Robotic Approach, 217.
63. Sumaarsana, I. K. R., Putra, I. G. A. M. A., & Sari, N. M. A. (2026). Surgical Stabilization of Rib Fractures: Current Evidence and Considerations for Posterior Rib Fractures. Annals of Thoracic and Cardiovascular Surgery, 32(1), ra-26.
64. Taran, S., Cho, S. M., & Stevens, R. D. (2023). Mechanical ventilation in patients with traumatic brain injury: is it so different?. Neurocritical care, 38(1), 178-191.
65. Temurovna, A. S. (2026). Improving Videothoracoscopic Diagnosis and Treatment of Thoracic Injuries. Shokh Articles Library, 1(1).
66. van Aswegen, H. (2020). Physiotherapy management of patients with trunk trauma: A state-of-the-art review. The South African Journal of Physiotherapy, 76(1), 1406.
67. Vasquez, D. G., Berg, G. M., Srour, S. G., & Ali, K. (2020). Lung ultrasound for detecting pneumothorax in injured children: preliminary experience at a community-based Level II pediatric trauma center. Pediatric radiology, 50(3), 329-337.
68. Vasse, M., Leone, M., Boyer, L., Michelet, P., Goudard, Y., Cardinale, M., ... & de Lesquen, H. (2023). Impact of the implementation of a trauma system on compliance with evidence-based clinical management guidelines in penetrating Thoracic trauma. European Journal of Trauma and Emergency Surgery, 49(1), 351-360.
69. Werle, R. W., Delevati, A. L., Righi, N. C., Nunes, G. S., Signori, L. U., & da Silva, A. M. V. (2026). Noninvasive ventilation in adults with blunt chest trauma: A meta-analysis of randomized clinical trials. Brazilian Journal of Physical Therapy, 30(1), 101540.
70. Wu, D., Geng, X., Wu, H., Liu, X., Liu, X., Ma, L., ... & Zhang, X. (2024). Effect of early mobilization on the development of pneumonia in patients with traumatic brain injury in the neurosurgical intensive care unit: A historical controls study. Nursing in Critical Care, 29(5), 962-973.
71. Yatera, K., & Yamasaki, K. (2025). Management of the diagnosis and treatment of pneumonia in an aging society. Internal Medicine, 64(4), 503-517.
72. Zhang, Z., Sun, L., Yan, W., Liang, Y., Wu, J., & Dai, Y. (2024). The application effect of preventive nursing intervention in patients with traumatic flail chest: A retrospective study. Medicine, 103(42), e39875.
73. Zhao, P., Ge, Q., Zheng, H., Luo, J., Song, X., & Hu, L. (2025). Clinical outcome analysis for surgical fixation versus conservative treatment on rib fractures: a systematic evaluation and meta-analysis. World Journal of Emergency Surgery, 20(1), 10.