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Nursing Interventions for Preventing Complications Associated with Chest Tube Drainage

Aishah Saud Alanazi[1], Talha Ahmad M Albalawi[2], Alharbi, Leena Hamaad H[3], Munayfah Mulaytan Hulayyil Alruwaili[4], Alkhaldi, Abdullah Faisal M[5], Hessa Khashman Alshammri[6], Bandar Mufadhi Alruwaili[7], Afaf Ayesh M Alruwaili[8], Wafgh Mutlg Mnzel Alrwaili[9], Manal Khalaf Qaryan Alanazi[10]

[1] Senior Specialist – Pediatric Nursing — King Salman Medical City – Madinah Health Cluster – Ministry of Health – Madinah – Madinah Region – Saudi Arabia. Email: aisalonazi@moh.gov.sa

[2] Nursing Specialist — Prince Mohammed bin Abdulaziz Medical City – Al Jouf Health Cluster – Ministry of Health – Sakaka – Al Jouf Region – Saudi Arabia. Email: talha990@hotmail.com

[3] Maternity and Children Hospital — Madinah Health Cluster – Ministry of Health – Madinah – Madinah Region – Saudi Arabia. Email: Rn.leenaalharbi@gmail.com

[4] Nursing Technician — Al Jouf Health Cluster – Ministry of Health – Sakaka – Al Jouf Region – Saudi Arabia. Email: ghazi2900@icloud.com

[5] Nursing Technician — Al Jouf Air Base, Northern Sector – Sakaka – Al Jouf Region – Saudi Arabia. Email: alkhaldy1440a@gmail.com

[6] Nursing Technician — Forensic Medical Services Administration, Forensic Medicine Center, Branch of the Ministry of Health in Hail Region – Ministry of Health – Hail – Hail Region – Saudi Arabia. Email: hhhaaa2244@hotmil.com

[7] Nursing Technician — Branch of the Ministry of Health in the Northern Borders Region – Ministry of Health – Arar – Northern Borders Region – Saudi Arabia. Email: bamalruwaili@moh.gov.sa

[8] Nursing Specialist — Al Jouf Health Cluster – Ministry of Health – Sakaka – Al Jouf Region – Saudi Arabia. Email: Afaalruwaili@moh.gov.sa

[9] Nursing Technician — Urgent Care Center – Al Jouf Health Cluster – Ministry of Health – Sakaka – Al Jouf Region – Saudi Arabia. Email: Walrwely@moh.gov.sa

[10] Nursing Technician — Eradah and Mental Health Complex – Northern Borders Health Cluster – Ministry of Health – Arar – Northern Borders Region – Saudi Arabia. Email: Manalka@MOH.goV.sa

ABSTRACT: Chest tube drainage is a commonly used procedure for managing conditions such as pneumothorax, hemothorax, pleural effusion, and other disorders affecting normal respiratory function. However, patients undergoing chest tube insertion and drainage are at risk of several complications, including infection, bleeding, tube displacement or obstruction, subcutaneous emphysema, and respiratory deterioration. Nurses play a vital role in preventing these complications through continuous patient assessment, appropriate management of the drainage system, and adherence to evidence-based nursing practices. Essential nursing interventions include monitoring respiratory rate, oxygen saturation, breath sounds, vital signs, and the patient's overall respiratory status, as well as assessing the insertion site for signs of infection, bleeding, or subcutaneous

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emphysema. Effective nursing care also involves maintaining a closed and sterile drainage system, ensuring that the drainage unit remains below chest level, securing all connections, and checking the tubing regularly for kinks, dependent loops, or obstruction. Nurses should monitor the amount, color, and characteristics of drainage, recognize abnormal fluctuations in the water-seal chamber, and promptly report unexpected changes or signs of air leakage. Additionally, appropriate pain management, positioning, encouragement of deep breathing and coughing exercises, early mobilization when clinically appropriate, and patient education are important components of care. Regular documentation, adherence to institutional protocols, and timely recognition and management of complications contribute significantly to patient safety, improved respiratory outcomes, and reduced morbidity associated with chest tube drainage.

INTRODUCTION

Chest tube drainage, also known as tube thoracostomy, is one of the most frequently performed invasive procedures in acute care, emergency, thoracic surgery, and critical care settings. The procedure involves placing a flexible tube into the pleural space to evacuate air, blood, pus, or other fluid so that the lung can re-expand and normal cardiopulmonary mechanics can be restored [1]. It is used in the management of pneumothorax, pleural effusion, hemothorax, empyema, chylothorax, and as a routine part of postoperative care after thoracic and cardiac surgery [1], [2].

Although the technique is well established, it is not free of risk. National guidance on chest drain insertion emphasizes that the procedure should be performed by trained personnel, using aseptic technique and, whenever possible, image guidance, because inadvertent injury to thoracic and abdominal organs can be serious or even fatal [3]. Beyond the insertion itself, the period during which the tube remains in place is a time of continuous vulnerability for the patient, because the drainage system must remain airtight, patent, correctly positioned, and free of contamination for the entire duration of therapy.

A substantial body of literature describes the errors and complications that accompany chest tube placement and management. These include malposition, organ injury, bleeding, infection, subcutaneous emphysema, re-expansion pulmonary edema, tube obstruction, accidental dislodgement, persistent air leak, and pain [4], [5], [6]. Many of these events are not caused by the original insertion technique alone, but by deficiencies in the care delivered after the tube is in place. Early studies of tube thoracostomy had already shown that complication rates are closely related to the circumstances of insertion, the experience of the operator, and the quality of subsequent management [7].

Nurses are at the center of this post-insertion period. They assemble and prepare the equipment, assist the physician during insertion, monitor the patient and the drainage system around the clock, recognize early warning signs, mobilize and educate the patient, and assist with removal of the tube. Because nurses spend the greatest amount of time at the bedside, their knowledge, assessment skills, and consistent application of evidence-based practice are decisive in whether a complication is prevented, detected early, or allowed to progress [8].

The pleural space is a potential space between the visceral and parietal pleura that normally contains only a thin film of fluid and maintains a slightly subatmospheric pressure. This negative pressure keeps the lung inflated against the chest wall. When air, blood, or fluid accumulates in this space, the lung collapses partially or completely, ventilation and gas exchange are impaired, and in severe cases venous return and cardiac output are compromised, as in tension pneumothorax [1].

The therapeutic aim of chest tube drainage is therefore to remove the abnormal contents and to re-establish negative intrapleural pressure. Achieving this goal depends on three physical conditions: the drainage path must remain open (patency), the system must prevent air from re-entering the pleural space (one-way flow), and the drainage unit must be kept below the level of the patient's chest so that gravity favors outflow. The traditional water-seal principle satisfies the second condition by allowing air to leave the chest on expiration or coughing while the column of water prevents its return on inspiration [8].

The position of the tube and of the drainage tubing also influences the efficiency of drainage. Experimental and clinical observations have shown that dependent loops, kinks, and fluid pooling in the tubing can increase resistance and alter the pressure transmitted to the pleural space, which reduces drainage efficiency [9]. These observations explain why many nursing interventions, such as keeping tubing free of loops and positioning the collection chamber below the chest, are not merely routine habits but have a direct physiological basis.

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Types of Chest Tubes and Drainage Systems

Chest tubes differ in diameter, material, and design, and the choice depends on the substance to be drained and the clinical context. Small-bore catheters, commonly in the range of 8 to 14 French, are often used for simple pneumothorax and free-flowing effusions, whereas large-bore tubes are generally preferred for hemothorax, viscous empyema, and situations in which a large volume of blood or air is expected, such as trauma and thoracic surgery [10]. Tubes may be straight or curved, may contain a trocar or be placed by the Seldinger technique, and may be connected to different types of drainage units [10].

Drainage systems have evolved from the classic single-bottle and three-bottle arrangements to commercially manufactured, disposable units that integrate a collection chamber, a water-seal chamber, and a suction control chamber. More recently, digital drainage systems have been introduced. These devices measure intrapleural pressure and air flow continuously and display the data objectively, which reduces observer variation in the assessment of air leaks and supports more consistent decisions about tube removal [11]. A randomized trial comparing digital and analog systems after lung resection reported that digital systems can offer practical advantages in the assessment of air leak and in the standardization of care [12]. The main features of the commonly used systems are summarized in Table 1.

Table 1. Common types of chest drainage systems and nursing considerations

System	Main characteristics	Typical use	Key nursing considerations
Traditional underwater-seal bottle	Single or multiple bottles; water seal acts as a one-way valve	Limited use in modern practice, low-resource settings	Keep bottle below chest level; maintain fluid level in the water seal; never lift above the chest
Disposable three-chamber unit	Collection, water-seal, and suction control chambers in one unit	Most hospital settings, trauma, post-operative care	Check water-seal level, suction setting, and fluid markings each shift; keep upright
Dry suction unit	Suction regulated by a dial instead of water	When adjustable and high suction levels are required	Verify dial setting and the indicator; confirm water-seal chamber is filled
One-way flutter (Heimlich) valve	Small valve allowing air to escape but not re-enter	Simple pneumothorax, ambulatory patients	Check that valve is oriented correctly; monitor for blockage by blood or fluid
Digital drainage system	Electronic pressure and air-flow measurement	Post-operative thoracic surgery, air leak monitoring	Verify battery and alarms; interpret flow trends; document readings

Regardless of the system used, nurses must be familiar with the specific device in their unit, since errors often arise from unfamiliarity with the equipment rather than from lack of general knowledge.

Indications for Chest Tube Insertion

The principal indications are summarized in Table 2. Understanding the indication helps the nurse anticipate the expected drainage pattern and the specific risks for each group of patients.

Table 2. Indications for chest tube drainage and associated nursing implications

Indication	Expected drainage	Specific nursing implications
Pneumothorax (spontaneous, traumatic, iatrogenic)	Air, bubbling in water seal initially	Monitor for continuous bubbling that suggests persistent air leak; assess respiratory status
Hemothorax	Blood, often large initial volume	Measure hourly output; watch for hemodynamic instability and signs of ongoing bleeding

Indication	Expected drainage	Specific nursing implications
Pleural effusion (malignant, parapneumonic, others)	Serous or serosanguinous fluid	Drain gradually where recommended to reduce risk of re-expansion pulmonary edema
Empyema and complicated parapneumonic effusion	Purulent, viscous fluid	Prevent tube blockage; strict aseptic technique; observe for sepsis
Post-operative thoracic or cardiac surgery	Serosanguinous drainage, decreasing over time	Monitor trends; observe for bleeding, air leak, and tamponade signs
Chylothorax	Milky fluid	Document character and volume; monitor nutritional status

The indications are consistent with those described in clinical reviews and guidelines on pleural disease management [1], [2], [3].

Complications Associated with Chest Tube Drainage

Complications of chest tube drainage can be classified according to the time at which they occur: during insertion, while the tube is in place, and at or after removal. Insertion-related complications include injury to the lung, diaphragm, liver, spleen, stomach, heart, or great vessels, intercostal vessel or nerve injury, and incorrect tube placement, with the risk being higher in emergency conditions and when insertion is performed without imaging guidance [13], [14]. Tubes may also be placed in a fissure, outside the pleural cavity, or in the subcutaneous tissue, which leads to ineffective drainage and potentially to subcutaneous emphysema [13].

Complications that occur while the tube is in place are mainly related to infection, malfunction, and patient factors. Empyema and wound infection are the most important infectious complications, particularly after trauma, and their frequency is influenced by aseptic technique, duration of drainage, and the underlying injury [7], [15]. Mechanical problems include kinking, clotting, blockage by fibrin or debris, disconnection, leakage at connection points, accidental dislodgement, and loss of the water seal. These events can lead to recurrent pneumothorax, retained hemothorax, tension physiology, and the need for repeated procedures [16]. Pain and restricted mobility are also frequent, and they contribute to reduced coughing, atelectasis, and pneumonia.

At the time of removal, the most feared complications are recurrent pneumothorax, wound infection, and persistent drainage or leakage at the site. Technique and timing of removal are therefore integral parts of the preventive nursing strategy. Table 3 links the major complications with their causes, early warning signs, and the primary nursing actions that are discussed in detail in the following sections.

Table 3. Major complications of chest tube drainage, early warning signs, and key preventive nursing actions

Complication	Common causes	Early warning signs	Key preventive nursing actions
Organ or vessel injury	Blind insertion, emergency placement, inadequate preparation	Sudden pain, bloody drainage, hypotension, abnormal drainage content	Prepare equipment and patient properly; assist with image-guided insertion; monitor vital signs closely
Tube malposition or dislodgement	Poor fixation, patient movement, traction on tubing	Reduced drainage, visible tube eyelet, subcutaneous emphysema, respiratory distress	Secure the tube; anchor tubing to the patient; give clear mobilization instructions
Infection (site infection, empyema)	Breaks in aseptic technique, prolonged drainage, wet or soiled dressing	Fever, purulent drainage, redness or swelling at site, raised white cell count	Hand hygiene; sterile dressing changes; early removal when criteria are met

Complication	Common causes	Early warning signs	Key preventive nursing actions
Tube obstruction	Clots, fibrin, kinks, dependent loops	Drainage stops suddenly, no respiratory fluctuation, rising dyspnea	Keep tubing free of kinks and loops; follow policy on patency maintenance; report changes immediately
Loss of water seal or air-tight integrity	Disconnection, cracked unit, loose connections	Continuous bubbling in water seal, deteriorating oxygen saturation	Secure and tape connections; keep unit upright; check for leaks systematically
Subcutaneous emphysema	Tube displacement, blocked tube, large air leak	Crepitus around site and chest wall, swelling	Assess skin around site each shift; mark the borders; escalate promptly
Re-expansion pulmonary edema	Rapid evacuation of large effusion or pneumothorax	Cough, dyspnea, frothy sputum, desaturation after drainage	Follow controlled drainage orders; observe the patient closely after drainage
Pain and impaired mobility	Tube irritation of pleura and intercostal nerves	Guarding, shallow breathing, refusal to cough or move	Regular pain assessment; analgesia as ordered; non-pharmacologic measures; assisted mobilization
Recurrent pneumothorax after removal	Incorrect removal technique, air leak not resolved	Sudden dyspnea, chest pain, decreased breath sounds	Assist with removal at the correct phase of respiration; apply occlusive dressing; post-removal monitoring

Reviews of chest tube complications consistently note that many of these events are potentially preventable and that vigilance during the entire period of drainage reduces morbidity [5], [6], [16].

Risk Factors for Complications

Risk factors for complications can be divided into patient-related, procedure-related, and system-related factors. Patient-related factors include trauma, severe underlying lung disease, obesity, coagulopathy, immunosuppression, poor nutritional status, and altered consciousness that leads to unintentional traction on the tube. Procedure-related factors include emergency insertion, operator inexperience, lack of imaging guidance, and inappropriate tube size or site selection [7], [13]. System-related factors include inadequate staffing, lack of standardized protocols, unfamiliar equipment, and insufficient training of nurses in chest drain management.

A long-standing observation is that morbidity from chest drains is reduced when units adopt clear protocols, restrict insertion to adequately trained clinicians, and ensure that nursing staff understand the equipment and the principles of its management [17]. This supports the view that complication prevention is a shared responsibility of the entire team, with nursing practice as the most continuous and most visible component.

The Role of the Nurse in Preventing Complications

The nursing role in chest tube care extends well beyond routine observation. It includes preparation, assistance, continuous assessment, equipment management, patient education, documentation, and communication with the medical team. A systematic review of the nursing management of chest drains concluded that many routine practices are based on tradition and local custom rather than on strong research evidence, and that standardization and further study are needed [18]. Despite this limitation, descriptive and expert sources agree on a core set of safe practices, including maintaining a closed system, keeping the drainage unit below chest level, regular assessment of the patient and the drain, and early recognition of abnormal findings [19], [20].

The preventive framework in this paper is organized around the phases of care. At each stage, the nurse's objectives are to reduce the likelihood of a complication, to detect it at the earliest possible moment, and to initiate the appropriate response without delay. A recent comprehensive review of chest tube management also supports a structured, protocol-based approach that covers selection, insertion, monitoring, and removal of the tube [21].

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Nursing Interventions Before Insertion

Preparation of the patient and the environment is the first opportunity to prevent harm. The nurse should verify the physician's order and the indication, confirm the side and site of insertion against imaging, and check the patient's identity. Laboratory results, particularly coagulation parameters and platelet count, should be reviewed and any abnormality reported before the procedure unless the situation is an emergency. Allergies, especially to local anesthetics, antiseptics, and latex, must be confirmed.

Explaining the procedure to the patient and obtaining informed consent, when the patient's condition permits, reduces anxiety and improves cooperation, which in turn lowers the risk of sudden movement during insertion. The patient should be positioned according to the operator's preference, commonly semi-recumbent or lateral with the affected side up and the arm raised above the head to expose the insertion site. Baseline vital signs, oxygen saturation, respiratory rate, and breath sounds should be recorded so that later changes can be interpreted correctly.

The equipment must be complete, sterile, and tested before use. The tube size, drainage unit, sterile water for the water seal, suction source, sterile dressing, suture material, and emergency supplies should be at the bedside. Checking the drainage unit for cracks and confirming that connectors are compatible prevents later leaks. Table 4 presents a practical checklist for the pre-insertion phase.

Table 4. Pre-insertion nursing checklist and rationale

Nursing action	Rationale
Verify order, indication, side, and imaging	Prevents wrong-site insertion and unnecessary procedures
Review coagulation tests, platelets, anticoagulant therapy	Reduces risk of bleeding and hematoma
Check allergies (anesthetic, antiseptic, latex)	Prevents allergic reactions
Explain the procedure and obtain consent	Reduces anxiety, improves cooperation, meets ethical requirements
Record baseline vital signs, saturation, and breath sounds	Provides a reference for detecting deterioration
Prepare sterile tray, tube, drainage unit, water seal, suction	Ensures safe and uninterrupted insertion and connection
Administer analgesia or sedation as ordered	Controls pain and prevents sudden patient movement
Position the patient appropriately	Provides access to the insertion site and reduces risk of injury

Nursing Interventions During Insertion

During insertion, the nurse assists the operator, maintains the sterile field, and monitors the patient. Hand hygiene, use of sterile gloves and gowns, skin antisepsis, and a wide sterile drape are fundamental, since breaches of asepsis at this stage increase the risk of site infection and empyema [7], [15]. The nurse should observe the patient's color, breathing pattern, heart rate, and level of consciousness continuously, reassure the patient verbally, and report immediately any sudden pain, hypotension, arrhythmia, or desaturation, which may indicate organ injury or a vasovagal reaction [13], [14].

After the tube is positioned, the nurse assists in connecting it to the drainage system, ensuring that all connections are tight and that the water-seal chamber is filled to the level specified by the manufacturer. The tube should be secured by suture and an occlusive sterile dressing, and the tubing should be anchored to the patient's skin or clothing in a way that avoids traction and allows free movement. An immediate chest radiograph is usually requested to confirm position and lung re-expansion, and the nurse should ensure that this is obtained and that the result is communicated.

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Nursing Interventions During the Period of Drainage

Systematic Assessment of the Patient

Assessment of the patient should be performed at regular intervals and whenever the patient's condition changes. It includes respiratory rate and effort, oxygen saturation, breath sounds, chest expansion, heart rate, blood pressure, temperature, level of consciousness, and pain. New or worsening dyspnea, tachycardia, hypotension, or reduced air entry should prompt an immediate check of the tube and the drainage system and notification of the physician, since these may signal obstruction, tension pneumothorax, or bleeding [19].

The skin around the insertion site should be inspected for redness, swelling, leakage, and subcutaneous emphysema. When crepitus is detected, its borders should be marked with a pen and the time recorded, so that extension can be recognized objectively on later examinations.

Assessment and Maintenance of the Drainage System

The drainage system should be checked at the beginning of each shift and at every patient contact. The nurse verifies that all connections are tight and taped, that the unit is upright and below the level of the chest, that the tubing is free of kinks, dependent loops, and compression, and that the water-seal and suction chambers contain the correct level of fluid. The collection chamber is marked with the date, time, and fluid level at regular intervals so that drainage rates can be calculated.

Fluctuation of the water level in the water-seal chamber with respiration (tidaling) indicates that the tube is patent and communicating with the pleural space, while its absence in a patient who is not on suction may suggest obstruction or complete lung re-expansion. Continuous bubbling in the water-seal chamber indicates an air leak, which may originate from the patient (a pleural or parenchymal leak) or from the system (a loose connection or damaged unit). The nurse can distinguish between these causes by briefly clamping the tube close to the chest wall only when this is permitted by local policy and the patient is not at risk of tension pneumothorax, and then by checking connections progressively from the patient toward the unit. Clamping should never be performed routinely and should never be prolonged, since it may convert a simple air leak into a tension pneumothorax.

Management of Suction

Suction is applied when additional negative pressure is needed to evacuate air or fluid or to expand the lung. The prescribed level must be set and checked regularly, and the nurse should confirm that the suction indicator or bubbling in the suction chamber is consistent with the order. In some patients, particularly after lung resection with an air leak, a trial of water seal without suction has been shown to shorten the duration of air leak and may allow earlier removal of the tube, while in other situations suction remains necessary [22]. The decision is made by the physician, but the nurse's careful observation of lung status, air leak, and subcutaneous emphysema during any change in suction provides the information needed to make it safely.

Maintaining Patency and Preventing Obstruction

Obstruction by clot, fibrin, or kinked tubing is one of the most common mechanical problems. The nurse should keep tubing straight and free of loops, ensure that the patient does not lie on the tube, and encourage position changes. Gentle manipulation of the tubing to move fluid toward the collection chamber may be used where unit policy allows. Aggressive stripping or milking of the tube, which can generate very high negative pressures within the pleural space, is not supported by strong evidence and is discouraged in many protocols [18], [21]. When drainage suddenly stops and the patient develops respiratory distress, the nurse should check the system for obstruction, notify the physician immediately, and prepare for urgent evaluation rather than attempting to clear a suspected blockage by unapproved methods.

Monitoring Drainage and Fluid Balance

The volume, color, and consistency of drainage should be recorded at least every shift, and more frequently in the first hours after insertion or surgery. A sudden increase in bloody drainage, commonly considered when it exceeds a threshold specified in local policy, requires urgent medical review. Purulent, cloudy, or foul-smelling fluid may indicate infection. A sudden cessation of drainage in the presence of symptoms suggests blockage, whereas a gradual decrease with improved clinical status is consistent with resolution. Drainage must be considered in the patient's overall fluid balance, especially in the first hours following the drainage of a large hemothorax or effusion.

In patients with large effusions, controlled drainage in staged volumes is often recommended by clinicians to reduce the risk of re-expansion pulmonary edema, and the nurse must clamp or unclamp the tube only according to explicit orders. After large-volume drainage, the nurse should watch closely for cough, chest tightness, dyspnea, and frothy sputum.

Prevention of Infection

Prevention of infection depends on consistent adherence to aseptic practice. Hand hygiene must be performed before and after any contact with the tube, dressing, or drainage unit. Dressing changes should be performed using sterile technique according to unit policy and whenever the dressing becomes wet, loose, or soiled. The drainage unit should remain below the level of the patient's chest at all times, including during transport, so that drained fluid cannot flow back into the pleural space. Emptying of the collection chamber, when required, should be done with a closed technique and sterile precautions. The nurse should also review daily whether the tube is still needed, since the duration of drainage is directly related to the risk of infection [15], [16]. Routine antibiotic prophylaxis is a medical decision and remains a topic of discussion, with evidence for presumptive antibiotics mainly in trauma [15].

Pain Management and Comfort

Pain is a frequent source of morbidity associated with chest tubes. Pain restricts deep breathing, coughing, and mobilization, which increases the risk of atelectasis and pneumonia. The nurse should assess pain regularly using a validated scale, administer prescribed analgesia on a scheduled basis rather than only on demand, and evaluate its effectiveness. Non-pharmacologic measures, including optimal positioning, splinting of the chest with a pillow during coughing, relaxation, and gentle distraction, can complement medication. Prompt attention to pain allows the patient to participate in deep breathing and early mobilization, which are essential for lung expansion.

Mobilization, Positioning, and Respiratory Care

Early mobilization improves lung expansion, reduces pulmonary and thromboembolic complications, and shortens hospital stay. Patients should be encouraged and assisted to sit, stand, and walk while the drainage system is kept below the chest and the tubing is protected from traction. The nurse should teach the patient how to carry or hang the unit, how to avoid kinking the tube, and which movements to avoid. Deep breathing exercises, incentive spirometry, and effective coughing should be performed regularly. In bed, the patient should be positioned to avoid lying on the tube, and the head of the bed should be elevated as tolerated to facilitate breathing.

Table 5 summarizes the major nursing interventions during the drainage period together with their rationale and the complication they target.

Table 5. Nursing interventions during drainage, rationale, and targeted complications

Intervention	Rationale	Complication targeted
Shift and hourly assessment of respiratory status and vital signs	Early recognition of deterioration	Tension pneumothorax, bleeding, respiratory failure
Keep drainage unit upright and below chest level	Maintains gravity drainage and prevents back-flow	Reduced drainage, infection, recurrent pneumothorax
Check connections, tape, and system integrity	Maintains an airtight closed system	Air leak, loss of water seal, lung collapse
Keep tubing free of kinks and dependent loops	Preserves patency and low resistance	Obstruction, retained fluid
Observe tidaling and bubbling	Indicates patency and presence of air leak	Obstruction, persistent air leak
Measure and record drainage at regular intervals	Detects abnormal volume or character	Hemorrhage, infection

Intervention	Rationale	Complication targeted
Apply aseptic technique, hand hygiene, sterile dressing	Reduces microbial entry	Site infection, empyema
Securing tube and anchoring tubing	Prevents traction and displacement	Dislodgement, malposition
Scheduled analgesia and pain assessment	Enables deep breathing and mobilization	Atelectasis, pneumonia
Early mobilization and breathing exercises	Promotes lung expansion	Atelectasis, thromboembolism
Assess skin for subcutaneous emphysema	Identifies air escaping into tissues	Subcutaneous emphysema, blocked tube
Do not clamp unless ordered	Prevents air trapping	Tension pneumothorax

Troubleshooting Common Problems at the Bedside

Nurses often face urgent situations in which rapid and correct action prevents serious harm. Table 6 outlines the common problems, the immediate nursing response, and the situations in which the physician must be informed without delay.

Table 6. Common bedside problems and recommended nursing response

Problem	Immediate nursing response	Notify physician when
Tube disconnected from the drainage unit	Reconnect quickly using a sterile technique if possible; assess respiratory status; if contamination, follow policy for cleaning or replacing connector	Patient has dyspnea, desaturation, or the tube cannot be reconnected safely
Tube accidentally pulled out	Cover the site immediately with sterile occlusive dressing taped on three sides (or as per policy); assess breathing; call for help	Always, immediately
Drainage unit cracked or knocked over	Place the unit upright; if broken, replace or place the tube end in sterile water as an emergency water seal; monitor the patient	The patient deteriorates or the system cannot be restored
Sudden cessation of drainage with respiratory distress	Check for kinks, clamps, and loops; assess patient; prepare for urgent review	Always
Excessive bloody drainage	Record volume and time; check vital signs; ensure intravenous access	Drainage exceeds the policy threshold or hemodynamic change is present
New or increasing subcutaneous emphysema	Mark borders; check connections and patency; assess breathing	Spread of emphysema or breathing difficulty
Continuous bubbling in water seal	Check connections systematically from patient to unit; assess patient	Cause is not found or the patient is unstable
Fever or purulent drainage	Check temperature trend and site; obtain cultures as ordered	Always

For any accidental disconnection or dislodgement, protocols emphasize that the response must be immediate, calm, and specific to the nature of the problem, and that all staff should be familiar with these procedures [8], [19].

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Nursing Interventions During Chest Tube Removal

Removal of the tube is a critical moment because it is the point at which air can re-enter the pleural space. Decisions about removal are medical, but the nurse contributes by observing trends in drainage, air leak, and lung expansion, and by reporting these to the physician. Traditional criteria include resolution of air leak, full lung re-expansion on radiograph, and a daily drainage volume below a defined threshold. A randomized study found that removal at higher daily drainage volumes than traditionally accepted did not increase the need for reintervention, which supports earlier removal in appropriate patients and reduces exposure to complications related to the tube itself [23].

Before removal, the nurse prepares the patient and equipment, gives analgesia in advance, and explains the procedure and the expected sensations. The necessary supplies include sterile gloves, suture removal set, occlusive petroleum gauze dressing, and sterile dressings. During removal, the patient is instructed to perform a Valsalva maneuver or to breathe in a specific way according to the physician's preference. Comparative research has found that removing the tube at end-inspiration or at end-expiration results in a similar rate of recurrent pneumothorax, provided that the removal is rapid and the site is sealed immediately [24]. The tube is withdrawn in a single smooth motion while an assistant applies the occlusive dressing, and the purse-string suture, if present, is tied at once. Table 7 summarizes the steps and rationale.

Table 7. Nursing care at chest tube removal

Phase	Nursing action	Rationale
Before removal	Confirm order and removal criteria; give analgesia; explain steps; gather supplies	Reduces pain and anxiety; ensures smooth technique
Preparation	Perform hand hygiene; position the patient; ensure suction is discontinued as ordered	Maintains asepsis and prevents air entry
During removal	Coach breathing technique; assist with rapid withdrawal and immediate occlusive dressing	Prevents air entering the pleural space
Immediately after	Assess respiratory status; check dressing integrity	Detects early pneumothorax
Follow-up	Obtain chest radiograph as ordered; reassess at defined intervals	Confirms that the lung remains expanded

Nursing Care After Removal

After removal, the patient should be observed closely for at least the first hours for dyspnea, chest pain, tachycardia, falling oxygen saturation, and new subcutaneous emphysema, which may indicate recurrent pneumothorax. The dressing should be kept occlusive for the period specified by local policy and then inspected for leakage, bleeding, or infection. The nurse should also instruct the patient to report any sudden shortness of breath, chest pain, fever, or drainage from the site after discharge. Detailed clinical references describe the natural course of pleural conditions and the importance of follow-up after drainage, and these provide the basis for appropriate patient advice [25].

Patient and Family Education

Education improves safety, reduces anxiety, and supports the patient as an active partner in care. A summary of the key teaching points is presented in Table 8.

Table 8. Key patient and family education points

Topic	Teaching content
Purpose of the tube	Explain that the tube removes air or fluid so that the lung can expand
Keeping the system safe	Keep the unit below the chest and upright; avoid lying on or pulling the tubing; avoid disconnecting any part

Topic	Teaching content
Movement	Walk with the unit carried below the chest; ask for help when standing; avoid sudden movements
Breathing and coughing	Perform deep breathing and coughing exercises; splint the chest with a pillow
Pain	Report pain early so that analgesia can be given on time
Warning signs	Report sudden shortness of breath, increasing chest pain, swelling or crackling under the skin, fever, bleeding, or accidental disconnection
After removal	Keep the dressing dry and intact; report breathing difficulty or fluid leakage

Documentation and Communication

Accurate documentation allows continuity of care and early detection of trends. The record should include the date and time of insertion, tube size and site, type of drainage system, suction level, drainage volume and character at defined intervals, presence of air leak and tidaling, condition of the site and dressing, pain scores, patient education, and any complications with the actions taken. Clear handover communication, including the status of the system and any anticipated problems, ensures that the same level of vigilance is maintained across shifts.

Staff Education, Protocols, and Quality Improvement

Because nurses' practice depends on knowledge, systematic education and competency assessment in chest drain management are crucial. Training should include the underlying physiology, the function of each component of the drainage system, hands-on practice with equipment, emergency scenarios such as accidental disconnection, and the principles of aseptic care. Evidence-based protocols and bedside checklists help standardize practice and reduce variation, particularly in areas where chest drains are not managed daily [8], [21]. Audits of insertion technique, infection rates, accidental removal, and duration of drainage can then be used to evaluate performance and guide improvement.

Implications for Nursing Practice

The findings of this review suggest several practical implications. First, nursing units should adopt a clear, written protocol for chest drain care covering all phases from insertion through removal. Second, regular competency training and simulation of emergency situations should be provided for all staff who care for patients with chest tubes. Third, nurses should perform and document structured assessments at defined intervals, using checklists that include both the patient and the system. Fourth, patient education should begin early and be reinforced throughout the period of drainage. Fifth, the need for the tube should be reviewed daily with the medical team, with the aim of removing it as soon as criteria are met. Finally, further nursing research is needed in areas where practice still depends on tradition, such as tube manipulation, dressing choice, and optimal monitoring frequency [18].

LIMITATIONS

This paper is a narrative review that synthesizes selected published sources, many of which are descriptive reviews or expert guidance rather than high-quality randomized trials in nursing populations. The strength of the evidence therefore varies across interventions, and practices should be adapted to local policy, patient condition, and the instructions of the treating physician.

CONCLUSION

Chest tube drainage is a life-saving intervention, but its safety depends largely on the quality of nursing care delivered before, during, and after insertion. Most of the serious complications, including infection, tube obstruction, dislodgement, loss of system integrity, subcutaneous emphysema, and recurrent pneumothorax, can be prevented or detected early through structured assessment, strict aseptic practice, careful management of the drainage system, effective pain control, early mobilization, patient education, and skilled assistance at removal. Standardized protocols, continuous staff education, and accurate documentation consolidate these practices into reliable routine care. By applying these interventions consistently, nurses can substantially reduce morbidity, shorten the duration of drainage, and improve patient outcomes.

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