Chest Needle & Chest Tube Insertion

CLINICAL BEST PRACTICE GUIDELINE

College publications contain practice parameters and standards which should be considered by all Ontario Respiratory Therapists in the care of their clients and in the practice of the profession. College publications are developed in consultation with professional practice leaders and describe current professional expectations. It is important to note that these College publications may be used by the College or other bodies in determining whether appropriate standards of practice and professional responsibilities have been maintained.

JANUARY 2009

COLLEGE OF RESPIRATORY THERAPISTS OF ONTARIO

Acknowledgements

This respiratory therapy best practice guideline was developed by a working group of the College of Respiratory Therapists of Ontario's (CRTO) Registration Committee comprised of practicing Registered Respiratory Therapists.

A search for related articles was performed on PubMed, MD Consult, Ovid Medline, and CINAHL (Cumulative Index to Nursing & Allied Health Literature). On Ovid, three evidencebased medicine review databases were searched. These included ACP Journal Club (ACP), Cochrane Database of Systematic Reviews (CDSR), and Database of Abstracts of Reviews of Effects (DARE). Relevant electronic books on MD Consult and Ovid were reviewed. The following terms were used: chest tube, chest needle, thoracocentesis, percutaneous thoracostomy, thoracostomy, needle decompression, needle aspiration, heimlich valve, chest drainage, pneumothorax, pulmonary air leaks, haemothorax, pleural effusion, pleural drainage catheter, pigtail catheter, seldinger technique, chest drains and trocar. A general search engine web search was conducted on "Google", using the same terms identified above. A structured website search was conducted on the Public Health Agency of Canada (PHAC), and the Centres for Disease Control and Prevention (CDC).

We have endeavoured to integrate individual experience and practice with the best available clinically relevant evidence from research and other sources in order to help our members make informed decisions about patient/client care. The weight of literature used to develop the document is supported with a graded level of evidence.
These guidelines are not meant to be applied in a "cookbook" fashion or to replace individual expertise.

We encourage all CRTO members to incorporate learning activities related to certification programs into the CRTO's Quality Assurance (QA) professional portfolio.

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INTRODUCTION

The *Regulated Health Professions Act* (RHPA) sets out the framework for the regulation of health professions in Ontario. The primary purpose for the regulation of the health profession is to protect the public by ensuring that practitioners meet minimum qualifications and standards of practice. In order to focus on the issue of public protection the RHPA identifies thirteen "controlled acts". These acts consist of a variety of activities that if performed incorrectly could result in serious harm to the public.

The *Respiratory Therapy Act* (RTA) authorizes Respiratory Therapists to perform four controlled acts. The Prescribed Procedures O. Reg 596/94 outlines a mandatory safeguard to help protect the public from harm that might occur when advanced prescribed procedures such as chest needle/ tube insertion are performed. The College of Respiratory Therapists of Ontario (CRTO) adheres to this regulation, and requires that members performing these controlled acts undergo a certification program approved by the Registration Committee of the CRTO. Chest tube and needle insertion, are examples of advanced prescribed procedures below the dermis which carry a greater risk for the public and so necessitate that a CRTO approved certification program be in place prior to the procedure being performed on a patient/client. For more on legislation and policies please visit the CRTO's web site: http://www.crto.on.ca/resources.aspx.

This respiratory therapy clinical best practice guideline (CBPG) is **not** intended to replace any current certification programs that have been approved by the Registration Committee of the CRTO. The purpose of these evidence-based guidelines are to provide a consistent approach to the development of certification programs/process which are required for the performance of prescribed procedures below the dermis under *Ontario Regulation 596/94*. **RRTs may use this guideline as the learning package for your certification program. For more information on this process, please see the CRTO's professional practice guideline (PPG) Certification Programs for Advanced Prescribed Procedures Below the Dermis at http://www.crto.on.ca/pdf/PPG/APPBD.pdf**.

The advanced procedures of chest tube and needle insertion share many common elements and so are discussed together in this document for ease.

This best practice guideline contains evidence-based clinical resources to support respiratory therapy practice in order to make informed patient care decisions and provide the best care possible. Evidence-based practice is the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients/clients. The practice of evidence-based medicine means integrating individual clinical expertise and experience with the best available clinically relevant evidence from systematic research. (Sackett et al, 2005 [LOE8])

INTERPRETATION OF EVIDENCE

References used throughout the body of the document will have a level of evidence (LOE) cited to indicate the quality and strength of the literature used. For example, a randomized clinical trial, will have LOE1 as a superscript, to identify it as having a Level of Evidence of 1 which is considered the strongest evidence available. The table below provides a description each LOE.

Levels of Evidence (LOE)

Level 1	Randomized clinical trials or meta-analyses of multiple clinical trials with substantial treatment effects.
Level 2	Randomized clinical trials with smaller or less significant treatment effects.
Level 3	Prospective, controlled, nonrandomized cohort studies.
Level 4	Historic, nonrandomized cohort or case-control studies.
Level 5	Case-series; patients compiled in serial fashion, control group lacking.
Level 6	Animal studies or mechanical model studies.
Level 7	Extrapolations from existing data collected for other purposes, theoretical analyses, e.g. critical reviews.
Level 8	Rational conjecture (common sense); common practices accepted before evidence-based guidelines. This includes material from textbooks, and editorials.

Adapted from the American Heart Association (AHA), Evidence Evaluation Process Used for the development of cardiopulmonary resuscitation (CPR) and Emergency cardiovascular care guidelines (ECC), 2005.

Certification Program Template for Chest Tube & Needle Insertion

The CRTO requires that certain components be included in the certification program. The required content is described in the CRTO professional practice guideline (PPG) on *Certification Programs for Advanced Prescribed Procedures Below the Dermis. For further information the following link will take you to a list of available practice guidelines on the CRTO's Web site: www.crto.on.ca/pdf/PPG/APPBD.pdf*

Below is a **suggested** content list to be used in the development of a certification program for chest needle & chest tube insertion. Items **A through G are required content,** as described in the *Certification Programs for Advanced Prescribed Procedures Below the Dermis PPG*. All other items further support the information to be incorporated into a certification program.

Contents:

A. Certification and recertification requirements
B. Nature and purpose of the procedure
C. Learning Objectives
D. Anatomy & Physiology
E. Indications and Contraindications
F. Risk Factors, Complications and their Management
G. Technique
H. References
I. Appendix
J. Certification Log
K. Competency Checklist
L. Test
M. Policy and Procedure

A. Certification and Recertification Requirements

Only Registered Respiratory Therapists (RRT) who hold a general certificate of registration, without terms and conditions, are authorized to perform an advanced prescribed procedure below the dermis, such as chest tube and chest needle insertion, aspiration, reposition and removal. Although authorized to perform the procedure, the *Respiratory Therapy Act* details the requirement of an order to enable the RT to proceed with the cannulation. An order can be in the form of a direct order or a medical directive based on the specific needs and policies of the organization or practice/setting environment.

To obtain initial certification the RRT must complete the CRTO approved certification program (O.Reg 596/94). In order to maintain certification or to be considered recertified, competence must be demonstrated under direct supervision at a minimum of every two years. This may include a review of related experience, verbal and/or written evaluation of knowledge.

A certification program is made up of three components:

I. Knowledge Component
II. Observation Component
III. Demonstration Component

The purpose of a certification package is to help the learner navigate the required theory and to provide a foundation for the clinical portion which will solidify understanding of all aspects of the procedure.

Knowledge Component – The knowledge component can be evaluated by a written or verbal examination. It is recommended that a minimum mark be required in order to proceed to the observation component. An estimate of the time required to complete this portion should be described.

Observation Component – After successful completion of the knowledge component the RRT will advance to review of the skill in a simulated setting under the direction of a certified clinician. The intent of this portion of the program is to provide a safe setting for the review of the skill and competencies required in order to be successful in performing the procedure on a patient. An estimate of the time required to complete this portion should be described.

Demonstration Component – This portion requires that the procedure be performed on a patient, under direct observation by a clinician certified in the procedure and who has the skills required to teach effectively. The decision as to who the clinician(s) are, should be determined based on internal resources. There is no evidence to support the decision of how many times the procedure should be repeated in order to determine competence. There is only an understanding that proficiency does come with practice and that ongoing evaluation is needed in order to ensure competency.

B. Nature and Purpose of the Procedure

Each facility will have a rationale for having an RRT assume the added responsibility of performing this advanced procedure of chest tube and needle insertion. The reasoning provided here has been described in certification programs that have been already approved by the CRTO.

Describing the nature and purpose helps establish the foundation for performing the procedure so that all readers understand its merits.

1. To standardize the approach used to perform chest tube and needle insertion performed by the Registered Respiratory Therapist based on good technique, clinical expertise and evidence-based practice.

2. To guide infection control practice related to chest tube and needle insertion, in order to minimize the incidence of infectious complications.

3. To expedite patient care by improving timeliness of providing chest tube and needle insertion in those situations where the physician is not immediately available.

4. To increase the numbers of qualified clinicians available to perform the procedure in order to expedite patient care.

5. To improve utilization of specialized personnel that is in-house and immediately available to assist in emergency-related circumstances (e.g., tension pneumothorax).

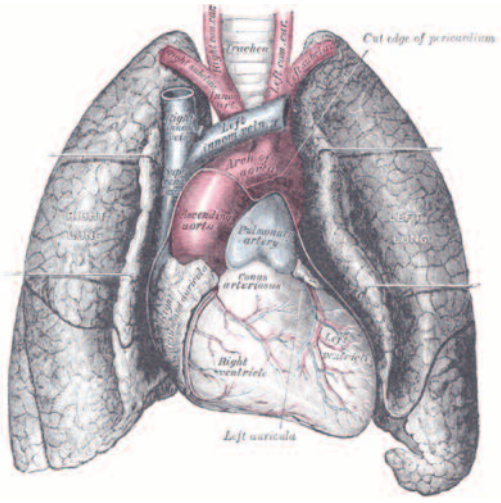
6. To increase the skill set of the RRT when assisting health care professionals during chest tube and needle insertion. The RRT can provide clinical expertise and enhanced technical troubleshooting advice.

C. Learning Objectives

Objectives should be clear, concise and measurable. They should reflect back on curriculum content and focus on key take-away messages. Below is a list of possible objectives that may be included in the development of your certification program.

1. State the standard/policy and medical directive (if applicable).
2. Demonstrate familiarity with the equipment used.
3. Describe the indications and contraindications.
4. Assess patient appropriateness for procedure, and the need for prevention and management of pain.
5. Demonstrate appropriate knowledge of the anatomy.
6. List the potential complications and discuss their prevention and management.
7. Demonstrate an understanding of pharmacology associated with the procedure.
8. Demonstrate appropriate infection control measures.
9. Demonstrate and discuss proper technique for cannulation.
10. Demonstrate successful assessment and cannulation on patient(s)/client(s).

D. Anatomy



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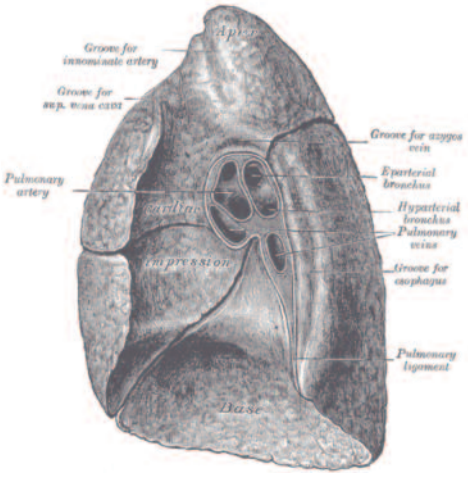
Thoracic Cavity

The thoracic cavity contains the lungs, heart, esophagus, major blood vessels and thymus. The bony thorax is made up of the sternum, ribs, thoracic vertebrae, clavicles and scapulae which protect the organs within the thorax, help expand and relax the chest wall during respiration and stabilize the chest wall against changes in intrapleural pressure. The mediastinum is the portion located between the lungs that houses the great vessels of the heart, and part of the trachea and esophagus.



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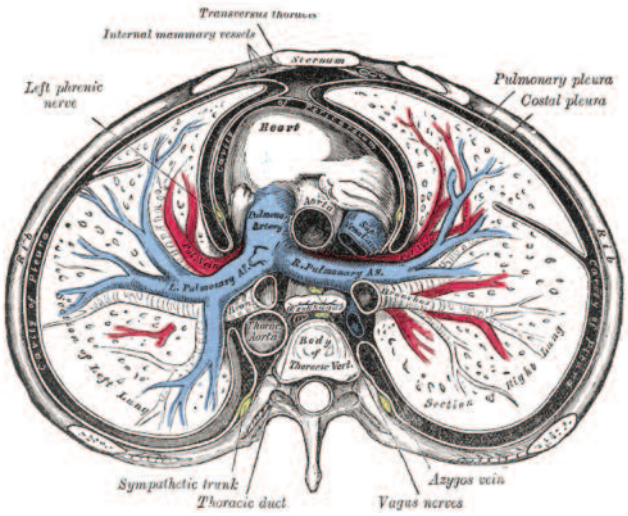
Lungs

The lungs are paired, lobed, cone shaped structures surrounded by the pleura. The right lung has three lobes and the left, two lobes. Above the centre of the mediastinal surface of each lung, is the root of the lung which connects the lung to the heart and trachea. It contains the pulmonary artery, pulmonary veins, bronchus and bronchial vessels. The medial border of the right lung is vertical whereas the left lung contains the cardiac notch, a concave impression molded to accommodate the shape of the heart. Above and behind the cardiac notch is a triangular depression called the hilum. Structures that make up the root enter and leave here. The lung base is the concave portion which lies on the diaphragm. The costal surface is convex as it is molded by the ribcage.

Pleura and Pleural Cavity

The pleura is made up of two parts - the visceral and parietal pleura. The visceral pleura (referred to as the pulmonary pleura in the illustration) is attached to the surface of the lung tissue. The parietal pleura (referred to as the costal pleura in the illustration, due to the specific intercostal portion) is thicker and is attached to the wall of the thorax. These are smooth serous membranes continuous with each other at the lung hila and pulmonary ligaments. The visceral pleura covers the lungs and adheres to all its surfaces, and then at the mediastinum becomes part of the parietal pleura. The parietal pleural is rooted to the chest wall with connective tissue and so moves with the thoracic wall. It is divided into four areas: the cervical pleura (cupula), costal pleura, mediastinal pleura, and superior phrenic arteries. The cupula covers the apex of the hemithorax and extends above the first rib; the costal pleura lines the inner surface of the sternum, ribs, and vertebrae and attaches to the chest wall; the mediastinal pleura covers the pericardium and other mediastinal structures; and the diaphragmatic pleura lines the diaphragm forming the floor of the pleural cavity. (Townsend, 2004 LOE8)



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The blood supply to the parietal pleura comes from systemic circulation, including the intercostal, internal mammary, anterior mediastinal and superior phrenic arteries. The visceral pleura receives blood from the systemic and pulmonary circulation. It is innervated by the vagus nerve and is relatively insensitive to pain. This contrasts to the parietal pleura, which is richly innervated by the intercostal and phrenic nerves, and is highly sensitive to pain. When stimulated, pain is severe and felt in the base of the neck and over the shoulder. (Townsend, 2004 LOE8)

Between the visceral and parietal pleura is the pleural space. This is a potential cavity that under normal circumstances contains only a small amount of pleural fluid (0.3 mL/kg of body weight), which acts to lubricate and transmit the forces of breathing between the lung and the chest wall.

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Pleura and Pleural Cavity (continued)

Over a 24 hour period, approximately 5 to 10 mL will have passed through the pleural space according to Starling's law of capillary exchange (balance of oncotic and hydrostatic pressures). The net pressure difference moves the fluid predominantly from the parietal pleura into the pleural space to be then reabsorbed mostly by the lymphatic of the parietal pleura. Though the lymphatics of the parietal pleura have an enormous ability to remove protein and fluid, a small imbalance of accumulation and absorption of pleural fluid will cause the development of a pleural effusion. (Townsend, 2004 LOE8)

E. Indications and Contraindications

Indications

Chest tubes are used to remove air (pneumothorax), fluid (pleural effusion, blood) or pus (empyema) in the thoracic space. In order to accomplish this, either a **needle thoracentesis** or **percutaneous thoracostomy** can be performed and for the purpose of this paper, the two procedures will be referred to in those terms.

There are various terms to describe the same thing, and these are explained in the Glossary of Terms.

Needle thoracentesis (also referred to as thoracocentesis or pleural tap) is a valuable tool used for diagnostic and therapeutic purposes. It is an invasive procedure to remove fluid/air form the pleural space via a hollow needle inserted in the midclavicular line in the 2nd intercostal space. It can help diagnose and classify transudative and exudative effusions, facilitating treatment of the underlying disease causing the effusion (Thomsen, 2006LOE7). Thoracentesis is indicated for patients with large pleural effusions and for those with smaller effusions who fail to respond to therapy. (Wilkins, 2003LOE8) In those presenting in respiratory distress, it can be used therapeutically to immediately relieve symptoms, as in the case of a tension pneumothorax or a large pleural effusion (Townsend, 2004LOE8).

Percutaneous thoracostomy involves the construction of an artificial opening in the chest. It is used when repeated thoracocentesis has been performed without successful resolution of the effusion, when a large effusion or air leak is present or if the air or fluid is expected to re-accumulate. Ambulatory patients/clients who present with repeated effusions as can occur in the case of malignancies, can have permanent pleural drainage catheters inserted, e.g. Hickman and Groshong (Townsend, 2004LOE8). Another alternative to the standard large bore chest tube is the pigtail catheter. This is a small bore catheter which can be connected to a three-way stopcock and syringe, or Heimlich valve with or without a drainage bag and to which a water seal drainage system can also be attached (Laws et al, 2003LOE7). These catheters are highly effective at draining thin effusions such as serous and chylous effusions (Roberts et al, 1998). Due to their size however, they are not recommended for evacuation of an acute haemothorax (Laws et al, 2003LOE7).

Pigtail catheters are inserted using the Seldinger technique rather than blunt dissection or trocar assistance (Jain et al, 2006[LOE5]). As a result, complications such as haemothorax; diaphragmatic rupture; splenic rupture; and hepatic rupture are not seen and overall, the catheter may be more comfortable, require less pain medication in order to manage, and decrease recovery time (Jain et al, 2006[LOE5]).

Pulmonary Air Leaks

A pneumothorax is the accumulation of air in the pleural space. It can be identified on chest x-ray by the separation of the visceral pleura from the parietal pleura and appears hyperlucent and without pulmonary markings. One method of classifying pneumothoraces involve dividing them into Spontaneous (e.g., Bullous disease), Traumatic (e.g., penetrating) and Iatrogenic (e.g., Mechanical Ventilation). Examples of traumatic insults that can cause a pneumothorax are penetrating or blunt chest injuries. Iatrogenic causes include mechanical ventilation, thoracocentesis, central venous catherization and lung biopsy. (Townsend, 2004[LOE8]) Spontaneous pneumothoraces are further sub-divided into primary and secondary. Primary spontaneous pneumothoraces occur in those without underlying disease; whereas secondary spontaneous pneumothoraces result because of such predisposing risk factors as chronic pulmonary obstructive disease, pulmonary embolism and cystic fibrosis. (Townsend, 2004[LOE8])

Pneumothoraces are more common in the newborn period than at any other time in life. This may be explained by the high intrathoracic pressures generated with the first few breaths, application of positive pressure mechanical ventilation in sick newborns, and the fragility of the premature neonate's lungs. Spontaneous pneumothoraces in this patient population are estimated to be about 1%, but many are asymptomatic and so do not require treatment. (McMillan et al, 2006[LOE8]).

Treatment of a pneumothorax depends on the cause, size and associated symptoms. The more symptomatic and less stable the patient, the more aggressive treatment should be. To help determine the size of the pneumothorax and to guide therapy, the American College of Chest Physicians describes pneumothoraces as small (<20% of the lung space on chest x-ray), moderate (20-40%) and large (>40%) (Baumann et al, 2001[LOE7]).

A small pneumothorax is <20% of the space occupied by the lung and can be monitored if the patient/client has few symptoms, as it will be reabsorbed from the pleural space in time. This occurs at a rate of 1-2% daily and can be followed by chest x-ray to ensure resolution. Moderate (20-40%) and large (>40%) pneumothoraces are usually associated with significant debilitating symptoms which require immediate attention. Simple needle decompression can relieve symptoms immediately by allowing the lung to begin re-expansion, but if it is expected that the leak may not resolve, chest needling should be followed by a chest tube insertion. In those situations where the pneumothorax was caused by a trauma, the risk of a tension pneumothorax is high and so a chest tube should always be considered if positive-pressure is going to be used or if the patient/client will be transported to another facility for treatment. (Townsend, 2004[LOE8])

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Indications and Contraindications (continued)

Increased risk of developing a pneumothorax for patients who have/ are:

- COPD
- Asthma
- Patients receiving positive pressure ventilation
- Aspiration
- Suffered chest trauma
- Post central line insertion
- Post thoracotomy procedure
- Parenchymal lung disease

In addition to the predisposing factors listed above, premature infants are susceptible to developing a pneumothorax in cases where they suffer from pulmonary hypoplasia, respiratory distress syndrome (RDS), persistent pulmonary hypertension of the newborn (PPHN) and sepsis. Term and post term infants are at risk of a pneumothorax with meconium aspiration syndrome (MAS) and a variety of congenital malformations.(Cloherty, 2003 LOE8) Spontaneous pneumothoraces can also occurs in approximately 1% of cases where there is no obvious lung disease. (Perlman, 1999 LOE8)

A **tension pneumothorax** results for the accumulation of air without a means of escape. This causes collapse of the affected lung and a medistinal shift. This often results in respiratory compromise and decreased venous return, leading to decreased cardiac output and hypotension. (Gomella, 2003 LOE8)

Recognition of a Tension Pneumothorax

- Dyspnea
- Cyanosis
- Restlessness & agitation
- Chest pain
- Tachypnea (grunting, nasal flaring and retractions in infants)
- Tachycardia (initially but may become bradycardic as air leak worsens)
- Jugular venous distension (JVD)
- Hypertensive (initially but may become hypotensive as air leak worsens)
- Tracheal deviation to the unaffected side
- Decreased breath sounds to the effected side
- Hypertympanic percussion note over the effected side
- Unequal chest expansion
- Pulsus paradoxus
- Subcutaneous emphysema
- Difficulty ventilating patient (requiring high airway pressures)

(it is important to remember that a tension pneumothorax can occur without any of the above findings)

Pleural Effusions

The presence of an abnormal amount of pleural fluid in the pleural space is referred to as a pleural effusion and there are many causes which are categorized under broad headings (e.g., transudative, exudative). (Wilkins, 2003 LOE8). Transudative pleural effusions result when fluid accumulate despite the fact that the integrity of the pleural space remains undamaged (e.g., congestive heart failure, cirrhosis). Exudative pleural effusions are more common and are a result of inflammation in the lung or pleura which causes a disruption in the pleural (e.g., infectious & neoplastic diseases, collagen-vascular disease-related, abdominal and gastrointestinal disease-related and others. (Townsend, 2004 LOE8) Therapy for pleural effusions depends on the causes and thoracentesis is often performed to determine the specific biochemical and cellular characteristics of the pleural effusion. (Wilkins, 2003 LOE8)

Hemothorax

Accumulation of blood within the pleural space is most commonly the result of traumatic injury. A hemothorax unrelated to injury can occur however, from a variety of different causes (e.g.) bullous emphysema, pulmonary malignancy. Blood loss may be massive in people with these conditions, as each side of the thorax can hold 30-40% of a person's blood volume. Significant signs of shock and poor perfusion may not occur until there is a loss of blood loss of 30% or more (Mancini, 2006 LOE8)

Needle aspiration is generally not indicated for definitive treatment of a hemothorax. Tube thoracostomy drainage, using a larger bore chest tube, is the primary method of management of this condition.

Chylothorax

This is the accumulation of lymph within the pleural space. This can occur as an after effect of thoracic surgical procedures (e.g., PDA ligation in paediatric/ neonatal population) or chest trauma causing the contents of the thoracic duct empty into the pleural space. It is more common on the left side because of the anatomy of the thoracic duct. Symptoms may mimic the effects of a pleural effusion; dyspnea, chest pain and fatigue. Management of a chylothorax consists initially of tube thoracostomy drainage. (Townsend, 2004 LOE8)

Empyema

Pleural effusions that are infectious in etiology can progress into an empyema, which is marked by the presence of bacteria within the pleural space and will usually necessitate drainage. (Wilkins, 2003 LOE8). If thoracocentesis fails, a percutaneous thoracostomy is indicated for drainage. If however, it becomes loculated or organized the chest tube will not drain the empyema, and surgical options such as debridement or decortication may be required. (Townsend, 2004 LOE8) Empyema should be considered in patients with community-aquired pneumonia who have large pleural effusions and fail to respond to therapy. (Wilkins, 2003 LOE8; Colice, 2000 LOE7)

Indications and Contraindications (continued)

Considerations

There are four main considerations when performing a chest needle or chest tube insertion. They are:

1. symptoms and size of the effusion or air;
2. site integrity;
3. coagulation status;
4. and presence of positive pressure mechanical ventilation.

Small primary pneumothoraces or fluid accumulations with minimal symptoms do not require treatment and can be followed on an out-patient basis (Baumann et al, 2001[LOE7]; Henry et al, 2003[LOE7]). Secondary pneumothoraces with minimal symptoms may or may not be treated, but require observation (Henry et al, 2003[LOE7]). Large pneumothoraces require immediate treatment regardless of the symptoms (Baumann et al, 2001[LOE7]). Generally, moderate and large effusions require drainage, regardless of the degree of presenting symptoms.

In addition to considering the symptoms and size, the local site where the needle or chest tube will be inserted must be taken into account. The site should not be infected, as passing a needle or tube through an infected site will further disrupt the epithelial barrier and possibly worsen the infection or contribute to its spread. (Thomsen et al, 2006[LOE8])

Thirdly, the coagulation status of the patient/client should be considered. However, in the situation of a tension pneumothorax the procedure will likely need to be performed regardless. At this time, there is limited data on the safety of thoracocentesis and percutaneous thoracostomy on those who present with abnormal platelet counts or clotting times. However, it is considered good practice to correct any coagulopathy or platelet abnormality prior to performing the procedure, when possible. (Thomsen et al, 2006[LOE8]; Laws et al, 2003[LOE7]).

Lastly, positive pressure mechanical ventilation increases the risk of lung penetration during the procedure. This is more of a concern when inserting a chest tube with a trocar. To decrease the risk of lung puncture, ultrasonography can be used. Alternatively, at the time of tube or needle insertion the patient/client can be disconnected from the ventilator. If a chest tube insertion is performed using a blunt dissection and no sharp instruments, this risk will be avoided (Thomsen et al, 2006[LOE8]; Laws et al, 2003[LOE7]).

INDICATIONS	CONTRAINDICATION
Needle Thoracentesis • Diagnostic and therapeutic purposes (e.g., pleural effusions of unknown cause) • To evacuate air or fluid from the pleural space when symptoms do not permit time for chest tube placement (e.g., tension pnemothorax) **Percutaneous Thoracostomy** • Therapeutic • Moderate and large pleural effusion or air leak • Repeated thoracocentesis • Recurrent effusion • Thoracic surgeries, e.g. esophageal repair • Pneumothorax related to trauma for those who may be transported by air or may be mechanically ventilated • Hemothorax • Chylothorax • Empyema • Other considerations (e.g., preventative measure after surgery to drain blood and prevent cardiac tamponade)	• Presenting symptoms (e.g. degree of ventilatory perfusion compromise) • Local skin infection at the proposed site of insertion • Size of fluid or air accumulation • Coagulation status • Primary or secondary pneumothorax • Positive pressure mechanical ventilation

F. Risk Factors, Complications and their Management

The rate of complications with a diagnostic or therapeutic needle thoracentesis is less than 0.5%, providing that the patient is relatively stable and properly prepared. Major complications can involve pnemothorx, hemothorax, bronchopleural fistula, unilateral pulmonary edema, systemic hypotension, infection and laceration of vessels/ organs . Pneumothorax is rare after thoracentesis and, when present, seldom require the replacement of a chest tube. (Thomsen,2006[LOE8]) Other complications of thoracocentesis include pain, coughing, localized infection, sub-cutaneous hematoma, anxiety and dyspnea.

Complication of Needle Thoracentesis	Prevention/ Management
Pneumothorax	Improper placement of the needle can cause a pneumothorax. Care needs to be taken when land-marking to ensure proper location of the needle.
Hemothorax	This can be caused when the needle punctures any vessel within the chest wall. Insert the needle at the midclavicular line to avoid the mammary artery. Needle should be inserted over the top of the rib to avoid the intercostal artery and vein. Blood return when the needle is inserted indicates a vessel has been punctured. A chest tube may be required and/ or surgical intervention if bleeding or air leak continues.
Bronchopleural fistula (BPF)	Proper land marking is essential to avoid puncturing the lung tissue. A chest tube may have to be placed if a BPF develops.
Unilateral pulmonary edema	Created by the rapid re-expansion of a lung through the use of excessive negative pressure.
Systemic hypotension	Can occur along with the unilateral pulmonary edema and /or as a vaso-vagal response.
Infection	The prevention of chest-tube associated infections requires strict adherence to aseptic techniques. (Moore, 2003[LOE8])
Needle laceration (lung, liver capsule or spleen)	Ensure proper land-marking, technique and patient positioning.
Subcutaneous emphysema	Occurs when released air becomes trapped within the subcutaneous tissue.
Air embolism	Caused when the needle enters a great vessel within the chest wall and air is accidentally introduced into the central circulation.

Insertion of a percutaneous thoracostomy tube can also result in injury to the liver, spleen or diaphragm if the tube is inadvertently placed inferior to the pleural space. Lung trauma, nerve damage, infection, aortic obstruction and re-expansion pulmonary edema can occur.

Mechanical problems can occur such as incorrect tube position and dislodgement of the chest tube from the chest wall. Air leaks can occur from tubing/ drainage system or from around the skin site. In general, if a chest tube is not functioning properly and the patient is deteriorating, the tube should be removed and another should be reinserted.

Complication of Percutaneous Thoracostomy	Prevention/Management
Malpositioned tube	Can lead to damage to liver, spleen, phrenic nerve injury and subcutaneous emphysema. Ensure proper land-marking prior to insertion.
Lung trauma	Can include perforation, hemorrhage, entrapment and bronchopleural fistula. This can be avoided by proper land marking and refraining from forcing the chest tube into the pleural cavity. Removal/ repositioning may be necessary for management of these situations.
Nerve injury	Caused by improper positioning of the thoracostomy tube. Passing the tube over the top of the rib will help avoid injury to the intercostal nerves running under the rib.
Infection	As with needle thoracentesis, the maintenance of sterile technique throughout the thoracostomy tube insertion will minimize the risk of infection. Empyema should be suspected when there is an increase in pleural fluid drainage accompanied by other signs and symptoms of infection. The risk of infection increases the longer the chest tube is in situ.
Aortic obstruction	Associated with thoracostomy tube insertion when the catheter tip is impinging on the aorta. May result in hypotension and may necessitate removal of the chest tube.
Re-expansion pulmonary edema	May occur upon rapid re-expansion of a collapsed lung; usually when high negative pressure is applied.
Hemothorax	Remove tube, unless bleeding is severe. In this case the tube should be clamped.

(Robert, 2004[LOE8])

continued...

Risk Factors, Complications and their Management (...continued)

As mentioned earlier, there is some evidence to support the use of smaller tubes (10 - 14F) to avoid some the complications, unless contraindicated by the presence of pleural fluid or a very large air leak Also, the use of catheter over guidewire systems (Seldinger technique) may prove to be as safe and effective as small caliber tubes.(Henry, 2003[LOE8]) Pig-tail catheters (size 9 - 12 F) have been found in some studies to be less traumatic and more comfortable for patients with efficacy as good as large-bore tubes (Jain, 2006[LOE7]).

An air leak may be present for a variable amount of time after tube thoracostomy. Should the air leak persist for more than 72 hours or the lung not completely re-expand, surgical intervention may be warranted. (Townsend, 2004,[LOE8]) Primary spontaneous pneumothorax tends to recur with increasing frequency after each episode, with a first time recurrence rate of 25 - 30%. Surgery for primary spontaneous pneumothorax has evolved over recent years from open thoracotomy to a minimally invasive video-assisted technique. This brings the recurrence rate down to approximately 5%.

For both procedures, in terms of infection prevention and control, hand washing remains the cornerstone of infection prevention and control (PIDAC, 2008 [LOE7]; CDC, 2002 [LOE7]). Hand hygiene reduces the transmission of micro-organisms. It includes hand washing, maintaining hand health, avoiding nail polish, artificial nails or jewelry and keeping nails trimmed and clean. The fingernail area can harbour considerable flora and other micro-organisms and artificial nails should be avoided. (CDC, 2002[LOE7]; PIDAC, 2008[LOE7])

For more information on good infection control practices please see the CRTO's Clinical Best Practice Guideline on Infection Prevention & Control
http://www.crto.on.ca/pdf/PPG/Infection_Control_CBPG.pdf

G. Practice Considerations and Technique

Close observation and oxygen therapy may be adequate in circumstances where the pneumothorax is causing no significant respiratory distress. The extrapulmonary air will usually resolve in 24 - 48 hours.(Cloherty, 2003 LOE8) However, if the patient is deteriorating a needle aspiration may be necessary.

Needle Thoracentesis

Equipment

- Needle size (dependent upon patient size)
    - Infant - #23 - 25 g butterfly needle or #22 - 24 g IV catheter
    - Child - # 18 g needle or #18 g angiocath
    - Adult - # 14 g needle (2" catheter-over-needle)
- Approved cleansing solution (e.g. 2% chlorhexidine, povidone-iodine or 70% isopropyl alcohol)
- Sterile H2 O (for low birth weight (LBW) infants of < 2,500 grams)
- "T" connector/ anaesthetic extension tubing
- 3-way stopcock
- 10 - 20ml syringe
- 1% Lidocaine (0.5% ml/kg/dose to a maximum of 5 ml/single injection)
- Sedation as required
- Bottle of sterile water
- Sterile gloves, gown and surgical mask.
- Sterile 2" x 2" gauze pads
- ¼" paper tape
- Sandbags, rolled towels and limb restraints
- Sterile drapes.

General Preparation

- Obtain direct order from Supervising Physician; unless performing procedure under pre-existing Medical Directive.
- Explain procedure to patient/ family or substitute decision maker, if patient condition allows.
- Determine appropriate sedation.
- Assemble equipment on the same side as the proposed puncture site.

Patient Preparation

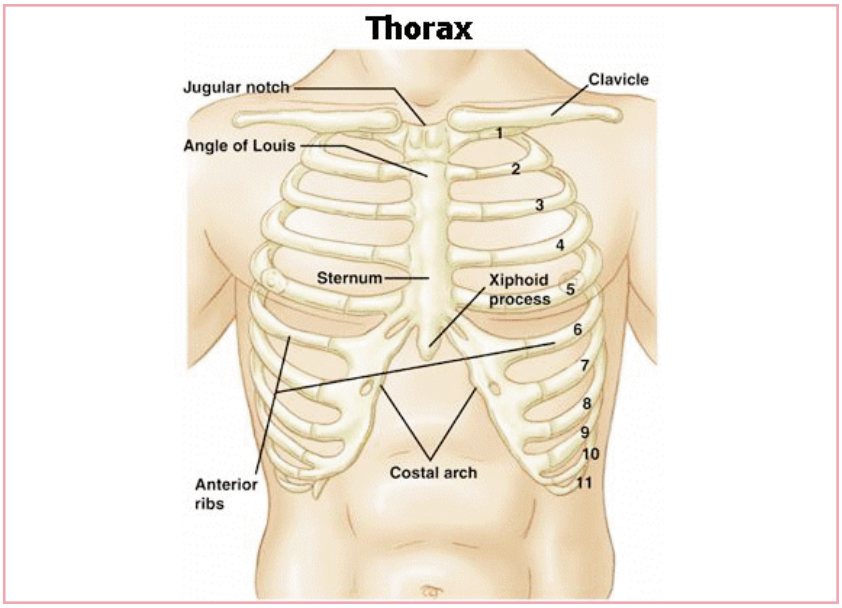
1. Place patient in the supine position (ensure thermoregulation is maintained in infants).
2. Maintain ambient oxygen concentration and /or ventilation as needed.
3. Monitor heart rate, colour and oxygen saturation.

continued...

Practice Considerations and Technique (continued)

Prior to performing procedure:

1. Ensure proper supplies have been assembled.
2. Apply mask, wash hands with antimicrobial soap and dry with sterile towel.
3. Organize supplies on sterile towel or tray.
4. Drape patient.



http://www.emergencymedicaled.com/images/thorax1.gif
Emergency Medical Ed
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Indication for Thoracentesis	Insertion Site
A. Emergent situation (e.g. tension pneumothorax)	2nd intercostal space, superior edge of rib, mid-clavicular line.
B. Gas accumulation with x-ray confirmation. (gas collects in the uppermost areas of the chest.)	3rd or 4th intercostal space, superior edge of rib, anterior axillary line.
C. Fluid accumulation with x-ray confirmation. (fluid accumulates in the most dependent areas.)	5th, 6th or 7th intercostal space, superior edge of rib, posterior axillary line.

Procedure for needle decompression in emergent situations

1. Landmark the chest to find the second intercostal space:
    - Palpate the clavicle on the affected side.
    - Palpate the joint between the manubrium and body of sternum (the second rib attaches to the sternum at the Angle of Louis).

2. Cleanse the insertion site with cleansing solution. Work from the identified site of insertion out to at least 3 -5 cm. Allow to dry for at least 1 minute, if possible. (Note: LBW infants have an increased risk of burns with cleansing solutions; therefore cleanse a smaller area, rinse the skin with sterile H2O after the application of 2% chlorhexidine has dried on the skin.)

3. Anaesthetize the insertion site subcutaneously initially and then advance to muscle and pleura using 1% Lidocaine. Wait 2 minutes to allow the anaesthetic to take effect, if possible.

4. Insert the needle firmly into the second intercostal space, midclavicular line just above the top of the third rib (inserting the needle at the superior edge of the rib avoids trauma to the intercostal nerves, arteries and veins)

5. When using an #18 g needle or # 18 g angiocath, attach a 3-way stopcock and a 20 ml (adult)/ 10 ml (neonate) syringe to the extension tubing.
    - Note: after inserting an angiocath into the chest, the stylet will need to be withdrawn before attaching the hub to the extension tubing and 3-way stopcock syringe setup.)
    - When a butterfly is being inserted, attach the 3-way stopcock and a syringe directly to the hub of the butterfly tubing.
    - As the needle is being advanced into the pleural cavity, a small amount of negative pressure should be applied to the plunger of the syringe (ensure that the 3-way stopcock is "open" between syringe and needle so gentle negative pressure can be exerted).

6. Advance the needle until a pop is felt (this will indicate pleural penetration). A rapid flow of air into the syringe occurs when the needle enters the pleural space. To avoid puncturing the great vessels or a lung, the needle should be advance no further once the pleural space has been entered. (Cloherty, 2003 LOE8)

7. If necessary, a continuous air leak can be aspirated while a chest tube is inserted. Remove needle and leave catheter in the pleural space open to atmosphere (a butterfly needle can be left in place). Otherwise, the needle is withdrawn after the airflow has stopped. (Cloherty, 2003 LOE8)

continued...

...continued

8. In the case of a tension pneumothorax, because of its ability to severely compromise respiratory efforts, the inserted thoracentesis needle hub should be attached to extension tubing that is connected to an underwater seal (sterile water bottle). This will prevent air from entering the pleural cavity and allow any further trapped air to escape.

9. A chest tube should be placed as soon as possible for definitive treatment, as required. Usually, needle thoracentesis is a temporary measure. If the pleural cavity requires ongoing drainage, a chest tube should be inserted. If the needle is to remain in place, secure its position with tape, or tegaderm. Ensure that the insertion site is kept clear of any objects that will either dislodge the needle, or that will potentially cause an infectious process.

10. If the needle is removed, and a chest tube is not inserted, monitor the patient closely for signs of reaccumulation of pleural air, or fluid.

11. Complete documentation, including the following information:
    - Date and time of procedure
    - Name of operator
    - Size of needle used
    - Number of attempts
    - Amount of air or fluid evacuated (if known)
    - Any problems encountered
    - Patients response to procedure
    - Results of CXR
    - Repositioning of chest needle, if required.
    - Interventions performed during procedure (e.g. sedation)

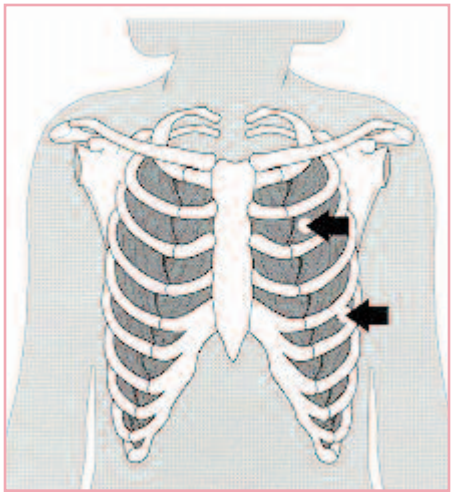
Removal of Thoracentesis Needle

1. To effectively remove the needle from its insertion site, the patient must be positioned for optimal visualization of the site, and restrained as required.

2. Rapidly remove the needle from the chest, and immediately cover the insertion site with sterile 2"x 2" gauze pads. After the gauze pads have been withdrawn from the area (approximately 1 minute), apply an occlusive dressing to the site.

3. Document date, name of person who removed the needle and patient response to the procedure.

Percutaneous Thoracostomy



http://www.uwhealth.org/images/ewebeditpro/uploadimages/5384_Figure_1.jpg
UW Health
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Continuous air leaks can result in severe hemodynamic compromise if left untreated, especially in the neonatal population. (Cloherty, 2003 LOE8) Although a physical examination may assist in the diagnosis of a pneumothorax, the precise location of pleural air or fluid accumulation is determined by examining the AP and cross-table lateral chest films. There is not evidence in adults that tube location affects its ability to drain accumulated fluid. (Roberts, 2004LOE8)

Chest tubes are inserted through the chest wall and into the pleural space by using either blunt dissection or the Seldinger technique. Small bore tubes (8-14F) are usually inserted by a Seldinger technique and medium bore tubes (16 -24 F) can be inserted using either method. Larger bore tubes (> 24 F) require blunt dissection. (Laws, 2003LOE7)

Percutaneous pigtail catheters are a thoracostomy tube that can be inserted using the Seldinger technique. They have been found to be high effective in the drainage of pleural effusions and somewhat less efficacious in draining pneumothoraces. However, infants and smaller children seem to have higher rates of resolution of pleural air and fluid from placement of pigtail catheters than larger children. These smaller and more flexible catheters are inserted by the Seidinger needle-guide wire method. They can reduce the complications seen with traditional large-bore tubes inserted by the dissection method. (Roberts, 1998 LOE7) A needle and syringe are used to localize the position for insertion and then a guidewire is passed down the hub of the needle, the needle is removed and the tract is enlarged with a dilator. The catheter can then be passed into the thoracic cavity along the wire. (Laws, 2003LOE8) The use of percutaneous thoracostomy tubes like pigtail catheters may be contraindicated in more severe conditions (e.g., major pneumothorax of >20%, tension pneumothorax). (Gormella, 2006LOE8)

Note: The procedure described in the following pages is for blunt dissection.

Percutaneous Tube Insertion

Guidelines for Chest Tube Size Selection

Age	Chest Tube Size
Newborn < 2000g	# 8-10 F
Newborn > 2000g	# 12 F
Infant	# 12 F
Child < 20 kg	# 16 F
Child > 20 kg and adult	# 20 - 28 F

Equipment

- Sterile mask, cap, gown & gloves
- Sterile surgical drapes
- Chest tube tray that contains:
    - Scalpel & blade
        - # 15 (neonate - paeds)
        - # 22 (adult)
    - 2 straight haemostats
    - Suture scissors
    - Needle driver
    - 2 curved mosquitoes (neonates)
    - 2 curved kelly hemostats (paeds)
- 3.0 or 4.0 silk suture
- Chest tube(s) of age appropriate size (see chart)
- Antiseptic skin preparation (e.g., Chlorhexidine 2% swabs)
- Sterile H_2O (for LBW infants of < 2,500 grams)
- 1% Lidocaine
- 3 ml sterile syringe
- Occlusive dressing
- 4” x 4”; 2” x 2” sterile or keyhole gauze pads
- Cloth roll and restraints
- Sedation/analgesia as required
- Chest drainage device. (e.g., Heimlich one-way flutter valve, Pleur-evac)

General Preparation

- Obtain direct order from Supervising Physician; unless performing procedure under a pre-existing Medical Directive.
- Explain procedure to patient/ family or substitute decision maker, if patient condition allows.
- Ensure a clean working environment and assemble supplies.
- The equipment and the operator should be on the same side as the proposed puncture site, facing the patient's head.

Patient Preparation

1. Administer sedation as required.

2. Place patient in a supine position (ensuring thermoregulation is maintained for neonates). The patient's arm raised above the head on the insertion side to better expose the area. (Restraining infants/ child's hand and feet may be necessary to prevent contamination of the sterile field and to allow proper visualization and insertion of the chest tube. Positioning infants with their affected side up may improve maneuverability.) (McMillian, 2006[LOE8])

3. Maintain ambient oxygen concentration and /or ventilation as needed.

4. Obtain baseline vital signs and SaO2. Supplemental oxygen is usually applied. Monitor heart rate, colour and oxygen saturation.

5. For anterior axillary line insertions, the head of the bed can be elevated 30 - 60 degrees. This lowers the diaphragm and decreased the risk of injury to the diaphragm, spleen or liver. (Roberts, 2004[LOE8])

6. Be aware of known allergies and if patient is on anticoagulant therapy.

Assistant's Role

1. Assist operator with positioning and restraining. Patient should be positioned and restrained in a manner that enhances visualization of the chest field requiring chest tube insertion. Correct positioning will decrease the risk of patient injury. Once the location of air or fluid accumulation has been identified, position the patient so that the affected side is elevated, allowing for appropriate visualization of the insertion field (approximately 45 to 60 degrees). Ensure that proper supplies have been assembled.

2. Apply mask and wash hands with an antimicrobial soap.

3. Assist in locating appropriate landmarks before operator drapes patient.

4. Assisting in attaching drainage system to chest tube.

continued...

Operator's Role

1. Apply mask, perform sterile scrub and don sterile gown and gloves.

2. Estimate insertion distance. Using the chest tube, measure the distance from the insertion site to the apex of the lung and note the distance on the tube. (Proehl, 1993 LOE8)

3. Landmark the appropriate site.
    - The nipple is an anatomical landmark for the 4th intercostal space. Care should be taken to avoid the pectoralis muscle and the axillary artery.
    - Chose appropriate insertion site at the 4th or 5th intercostal space at the midaxillary line.

4. Using the sterile field of the surgical tray, prepare the catheter for insertion. Clamp the end of the catheter that will be connected to the drainage system; this action will prevent air from entering the pleural cavity once the tube is inserted. Squeeze the end of the catheter to be inserted, between the blades of a curved hemostat/ forcep. Ensure that the hemostat/ forcep blades protrude a few millimeters beyond the catheter.

5. Once the insertion site is identified, cleanse the area with Chlorhexidine 2% thoroughly; working from the identified site of insertion out to at least 3 -5 cm. Allow Chlorhexidine to dry for at least 1 minute. (As with thoracentesis procedures, care needs to be taken with LBW infants in order to prevent burns to their delicate skin.)

6. Drape the desired anatomical region with sterile towels to create a surgical field. Avoid covering the patient's head. Be careful to leave head and neck visible.

7. If patient condition permits, anaesthetize the insertion site subcutaneously first, and then advance to muscle and pleura using 1% Lidocaine. This infiltrates the muscle, periosteum and parietal pleura in the area of the tube's passage. (Roberts, 2004 LOE8) Wait 2 minutes to allow anaesthetic to take effect.

8. Using the scalpel, create a superficial, horizontal incision (parallel to the rib). The size of the incision will depend on the age/ size of the patient (2 -3 cm in adults), but it is to be noted that a common error is to make the skin incision too small, so that it is difficult to create an adequate track. (Roberts,2004LOE8) To avoid damaging the great vessel the incision will be made just above the edge of the rib; the intercostal nerves, arteries, and veins lie just below the ribs. In very small infants, the distinction between the top of one rib, and the bottom of the other can be difficult to make.

9. Upon completing the incision, insert a closed haemostat (for adult/ paediatric patients) or a closed mosquito forcep (for neonates) into the incision. The haemostat/ forcep points should be positioned down towards the rib, as the device is slowly opened. This process requires several separating maneuvers

with the haemostat/ forcep. A firm but gentle downward pressure is usually necessary to overcome resistance to separation and only a small amount of tissue will be separated with each attempt. Using the tip of the haemostat/ forcep, carefully puncture the pleura just above the rib, and spread it apart gently. This maneuver creates a subcutaneous tunnel that will aid in closing the tract once the tube is removed.

10. After penetrating the pleura with the instrument, a rush of air if often audible.

11. Grasp the curved haemostat which is holding the catheter and direct the catheter through the incision into the pleural cavity. Once this is achieved, stabilize the catheter with the opposite hand and release it from the haemostat. Slowly remove the haemostat from the chest and advance the catheter to the desired position. Condensation in the lumen of the tube indicates that it has entered the pleural space. Its entry site should be palpated to ensure that it is not in the subcutaneous tissue. (McMillian, 2006 LOE8)

12. In most cases, the catheter will need to be directed anteriorly and superiorly. To direct the chest tube anteriorly rotate the haemostat so that the curve points anteriorly. Advance the chest tube after releasing the haemostat. Ensure that the eyes of catheter are within the pleural space. Moisture that is present within the tube usually confirms its proper placement within the intrapleural cavity.

13. If it is the practice of your facility, you may place a purse string suture around the tube and then secure the chest tube by wrapping and then tying the skin suture around the tube. A second loop may be placed around the chest tube at a position 2-4 cm from the skin surface. (Cloherty, 2003 LOE8)

14. Cover insertion site with an occlusive dressing, taking care not to use so much tape as to make chest examination difficult and possibly delay the discovery of a displaced tube. (Cloherty, 2003 LOE8) The use of tegaderm over the insertion site permits visualization of the field. For older infants and children, wrap a sterile strip of sulfa-tulle around the tube insertion site followed by key-hole gauze pads. Secure the dressing with waterproof tape.

15. After securing the chest tube, connect the chest tube to the blue end of the Heimlich Chest Drain/ or to drainage system of choice. The catheter should be taped to the valve/ drainage system to prevent accidental dislodging.

16. Coil tubing on bed and secure tubing with a safety loop in order to avoid tension being applies directly to the site of insertion.

DO NOT UNCLAMP THE CHEST TUBE UNTIL THE DRAINAGE SYSTEM IS SECURELY CONNECTED. THIS WILL PREVENT THE INSPIRATION OF AIR INTO THE PLEURAL CAVITY.

continued...

Operator's Role (continued)

17. Obtain a CXR to verify correct catheter placement, and to check for any residual/ reaccumulated air or fluid.

18. The following needs to be documented once the procedure is completed:
    - Date and time of procedure.
    - Name of operator.
    - Size of chest tube used.
    - Number of attempts.
    - Amount of fluid evacuated.
    - Any problems encountered.
    - Patients response to procedure.
    - Results of CXR.
    - Positioning of chest tube (if required).
    - Interventions performed during procedure (e.g., sedation).
    - Any other pertinent information.

Evaluation after insertion

- Monitor vital signs, SaO2, amount and type of drainage.
- Observe chest dressing (looking for any drainage at the site).
- Should be gentle, continuous bubbling in the water-seal chamber.
- Assess colour, amount of drainage*, changes in level of respiratory distress, chest pain and breath sounds.

* **Note that a sudden increase in drainage may indicate bleeding or hemorrhage; whereas a sudden decrease in drainage may indicate a possible clot.**

Chest Tube Removal

Criteria	Rationale
Minimal drainage: If the tube is no longer draining significant volumes of fluid and no air leak for a minimum of 24 hours (Roberts, 2004 LOE8)	Fluid from the pleural space has been removed, allowing the lung to re-expand.
Absence of air leak is documented: This can be verified by having the patient take a deep breath and cough. If bubbling is seen, the chest tube is not removed and the most responsible physician is notified.	Pleura of the re-expanded lung seal the holes on the internal tip of the chest tube, halting fluctuation in the water seal. This can be expected 2-3 days after chest tube insertion. Ongoing air leak requires continued use of the chest tube in order to maintain expansion of the lung.
Stable Respiratory Status: if the patient's respiratory status is stable (i.e. non-labored breathing, absence of shortness of breath, decreased use of accessory muscles, symmetrical respiratory excursions, RR<30/min (adults), breath sounds are consistent with known pathology, patient has been weaned from the ventilator). Vital signs (HR, BP, Pulse oximetry) should be within normal ranges. In addition, $EtCO_2$ and ABG's should be evaluated, where possible.	Aberrant respiratory findings can be an indication of an incomplete lung expansion. "Normal" (as in normal for the patient) breath sounds should be heard if re-expansion is complete
Chest Radiograph: Confirming resolution of collapse/ fluid accumulation as well as absence of any other complicating anomalies.	
Normal coagulation studies: If ordered, these should be within normal ranges. If not, the results should be reported to the supervising physician prior to removing the chest tube.	There is an increased risk of bleeding if coagulation is abnormal.
Valid medical order: Must be from a health care professional authorized to write orders. May be in the form of a direct order or a medical directive.	It is the CRTO's interpretation that the *Public Hospital Act, 1990* requires that there be a valid order to all procedures performed in a hospital. The RTA also stipulates that an RT must have an order for the authorized act "prescribed procedures below the dermis."

Equipment required for chest tube removal

- Suture removal kit
- Personal protective equipment (PPE) as dictated by the situation
- **Prepare occlusive dressing.** It is essential that this is ready in advance of removing the chest tube, as it needs to be applied immediately upon removal of the chest tube in order to prevent air from entering the pleural space. Prepared sterile occlusive dressing with non-petroleum based lubricant on top (e.g., Sofratule, Jelonet)
    - Place lubricant on a 4x4 and fold it in half, and then in half again, lubricant side out. Take an un-lubricated 4x4 and fold in the same fashion. Place the lubricated pad on top of the un-lubricated one and place both on top of 2 flat 4x4's (adult) ; 2x2's (neo/ paeds).
- 4-inch adhesive tape or elastic bandage (Elastoplast) cut into 3 strips of approx. 6 inches in length.

Procedure for removal of chest tube

1. Verify valid order.
2. Explain procedure to patient or substitute decision maker and obtain consent (where possible).
3. Ensure the patient has been pre-medicated as per physician's orders.
4. Position patient on side without the chest tube, in semi-upright position if possible.
5. Drape the insertion site.
6. Wash hands and don PPE.
7. Remove the dressing over the chest tube.
8. If a purse-string suture was put in place, then loosen it and clip the skin loop of the suture holding the tube to the skin. If there is not purse string sutures, then suturing equipment will need to be used to close the wound once the tube is removed. (Roberts, 2004[LOE8])
9. Clamp the tube and disconnect it from the connection tubing.
10. Retract tube 1 -2.5 cm in order to loosen it from where it may have adhered to the skin.
11. Ask patient to inspire maximally, if they are old enough; if not, remove tube on inspiration. Start to remove the chest tube as the patient reaches peak inspiration. It should be possible to remove a chest tube without having to use significant traction. If the tube does not move with relative ease, discontinue removal, secure tube and contact the most responsible physician.
12. If there is purse-string suture, it needs to be tied quickly and then covered with occlusive dressing.
13. Instruct patient to breathe normally and move them into a comfortable position.
14. Examine tube to ensure that all of it has been removed.
15. Dispose of equipment in container suitable for medical waste.
16. Ensure that a post removal chest x-ray is performed and that the supervising physician reviews it as soon as possible.

Note: Chest tubes should not be removed by the Respiratory Therapist without specific approval by a supervising physician in the following circumstances:

- If the patient is mechanically ventilated.
- If the patient demonstrates evidence of acute respiratory distress.
- If the INR is > 2.
- If PPT > 75 seconds.

Post Chest Tube Removal

1. Observe patient closely for complications (e.g., respiratory distress, air leaks or bleeding from the site, for at least the next 2 - 6 hours or as clinically necessary).
2. Assess lung sounds and observe patient for subcutaneous emphysema. Assess vital signs and oxygen saturations.
3. Assess patient's level of comfort post removal.

Documentation

- Record date and time of removal.
- Name of person performing the procedure.
- Appearance of the tube site
- Patient's response to the procedure (e.g., vital signs).
- Complications (e.g., pneumothorax, bleeding, skin necrosis, evidence of infection at site).

H. References

All sources used in the development of the certification program should be cited. This should include the CRTO professional practice guideline on *Certification Programs for Advanced Prescribed Procedures Below the Dermis and Infection Prevention and Control Clinical Best Practice Guidelines.*

I. Appendix

An appendix is a reference section. It can be used to describe information not included in the body of the certification program, but that is considered as a valuable resource to enhance understanding of the topic. It could cover such topics as medications or disease processes that are cited for example.

J. Certification Log

The CRTO Professional Practice Guideline, *Certification Programs for Advanced Prescribed Procedures Below the Dermis*, describes record keeping requirements. A certification log is one method that can be used to chronicle when chest needle/ chest tube procedure has been performed. It is a document, that at minimum captures the date when the procedure was performed, patient data, and the signature of the certifying clinician. It can take many forms, for example, a blank sheet can be used to manually enter the information, or a table can be created that lists the required information and contains space for documentation of each cannulation.

Certification information, such as a certification log, can be incorporated in the CRTO's Quality Assurance (QA) professional portfolio. The patient identifiers need only be removed.

K. Competency Checklist

A competency checklist is a tool that can be used to guide both the certifier and the learner and to ensure that the objectives of a certification program are met. It contains specific measurable components that need to be met 100% of the time when the procedure is performed.

Area/Item	Criteria	Complete Yes (√) or No (X)
Patient/Client Assessment	Assesses appropriateness for the procedure. Checks for order, allergies, patient identification, and any contraindications. Assesses need for pain prevention and management.	
Policy & Procedure	Knows the indications, contraindications, common complications their prevention and management.	
Infection Control	Adheres to good hand washing and aseptic technique.	
Anatomy	Demonstrates knowledge of the landmarks.	
Local Anaesthetic (if required)	For subdermal lidocaine ensures no flash back and waits for medication to take effect. For topical waits for medication to take effect.	
Equipment	Demonstrates knowledge of equipment and the steps required for success.	
Cannulation Technique	Appropriate local site selection for entry and angle of approach. Confirmation of correct tube placement.	
Documentation	Content documented as described in policy and signature with professional designation.	

L. Test

A test is an objective method employed to gauge the learner's ability to retain and apply information. It is a common educational tool used to help measure competency (knowledge, skills and judgment). A test can help reinforce key take away messages and act as a means of enforcing the objectives of a certification program.

M. Policy & Procedure

To support practice and ensure consistency between practitioners, each facility develops policies and procedures. Some facilities use the terms standard or protocol to describe the same. When a certification program is submitted to the CRTO for consideration, the organization's policy and procedure should also be tendered because it serves as part of the curriculum that must be reviewed by the learner undertaking the certification program. **Even if this practice guideline is to be utilized as the learning package for the certification program, it is still necessary to submit the facilities policy to the CRTO.**

A policy and procedure may contain a purpose statement and will include standards by which each Respiratory Therapist who performs the procedure will be held to. The following is a **suggested** template that can be used in order that all pertinent information is captured when developing a policy and procedure. An **asterisk*** identifies content that must be included in a policy and procedure in order to meet the minimum requirements of legislation and the criteria described in the *Certification Programs for Advanced Prescribed Procedures Below the Dermis* CRTO professional practice guideline.

Policy & Procedure Template

SUBJECT:*
Describes the site of cannulation and the patient population to which the procedure will apply.

Needle Thoracentesis in e.g., neonates.

ISSUING BODY:
Department or Program, e.g., Respiratory Therapy Services

EFFECTIVE DATE:
Date Policy is accepted and put into effect

According to the *Respiratory Therapy Act*, only those Registered Respiratory Therapists (RRTs) who hold a **general** certificate of registration can perform the controlled act of "a prescribed procedure below the dermis". This is further described in the "Prescribed Procedures Regulation" made under the Act, which requires that RRTs, who will be performing this procedure, complete a certification program that has been approved by the Registration Committee of the College of Respiratory Therapists of Ontario within two years before the procedure is performed.

Policy & Procedure Template (continued)

PURPOSE:

Describes the reason for the development of this policy and procedure.

1. To standardize the approach to, e.g., needle thoracentesis performed by Registered Respiratory Therapists.
2. To optimize patient care by, e.g., improving the timeliness of needle decompression in emergent situations.

STANDARDS:

Standards of Care outline the minimum expectations for patient care delivery in a specific area, within a discipline(s), or across the facility. They provide specific direction to the clinicians referred to in the standard. Standard statements contain expectations against which actual performance can be judged and must be met 100% of the time. The following three statements are the minimum that need to be included in a policy & procedure to meet the requirements of the CRTO.

1. Only a Registered Respiratory Therapists (RRT) who holds a general certificate of registration and has completed a certification program that has been approved by the Registration Committee of the CRTO can perform _____.*

2. Initial certification will include observation of ____ (e.g.) needle insertion under direct supervision by _____.*

3. In order to maintain competency and certification status, the skill of _____ must be observed under direct supervision by _____ _____times at minimum every two years.*

PROCEDURE:

Outlines step-by-step how a certain task or procedure should be completed. It provides direction for day-to-day practice related to the procedure.

DOCUMENTATION:

Describe how the procedure must be captured in the patient/client chart.

DEVELOPED IN CONSULTATION WITH:

Lists all the stakeholders consulted during the development of the standard/policy and procedure. This may include individual(s) and committees.

REFERENCES:

Details all the resources used to support the narrative.

Source: St. Joseph's Health Centre, Toronto, Standards of Care Template, 2006

Glossary of Terms

Heimlich valve: A one way valve system used to drain air or fluid from the pleural space and to which a bag can be attached to drain/collect fluid. The valve can also be attached to a chest tube and suction applied if needed. The Heimlich valve can be used in ambulatory patients/clients as it is small and can be held at any position, unlike traditional underwater drainage bottle systems. Also known as flutter valve.

Occlusive dressing: This is an air- and water-tight dressing that is used to seal the wound and provide a barrier against airborne infections. There are a variety of commercially prepared occlusive dressings available.

Percutaneous thoracostomy: The insertion of a flexible tube into the thorax to remove fluid or air from the pleural space. Also called tube thoracostomy, chest tube, chest drain and intercostal tube insertion.

Permanent drainage catheter: A permanent pleural drainage catheter that facilitates repeated thoracocentesis in ambulatory patients. Names of catheters used include Hickman and Groshong. These are also used for tunneled intraveonous access.

Pigtail Catheters: A small bore flexible catheter used to drain fluid or air from the pleural space. It is inserted using the Seldinger technique.

Needle Thoracentesis: The insertion of a needle or cannula into the thorax to remove fluid or air from the pleural space for diagnostic or therapeutic purposes. Also called thoracocentesis, pleural tap, chest needle (insertion) and needle aspiration.

Seldinger technique: A technique used to for the insertion of a catheter/tube into a vessel or cavity, which employs the use of a needle, guidewire and for certain procedures, also a dilator. Prior to the introduction of the Seldinger technique, sharp trocars were used to create lumens through which the catheter/tube would be inserted.

Trocar: A sharp pointed hollow metal surgical instrument used to introduce cannulas or tubing.

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Notes:

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Published January 2009

This practice Guideline will be updated as new evidence emerges or as practice evolves. Comments on this practice guideline are welcome and should be addressed to:

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