PROTOCOL FOR THE MANAGEMENT OF PLEURAL EFFUSIONS IN PREVIOUSLY HEALTHY PEDIATRIC PATIENTS

PURPOSE

Pleural effusion is an abnormal collection of fluid in the pleural space. Pleural effusion develops because of excessive filtration or defective absorption of accumulated fluid. Pleural effusion may be a primary manifestation or a secondary complication of many disorders.

Most common causes of pleural effusion in children include infection, congestive heart failure or malignancy. This protocol outlines management of pleural effusion caused by infections/pneumonia.

SITE APPLICABILITY

This practice can be carried out BCCH site-wide. Chest tube insertion is done in the interventional radiology suite or in the operating room.

PRACTICE LEVEL/COMPETENCIES

Physicians: respirologist, respirology fellow, senior CTU resident (or designate) may instill tPA and NS flushes into pigtail chest tube and manage care of child with a pleural effusion.

Registered Nurses in acute and critical care at BCCH have basic skills in caring for and monitoring patients with chest tubes.

DEFINITIONS

Parapneumonic effusion: pleural fluid collection in association with underlying pneumonia.

Empyema: the presence of pus in the pleural space.

Small effusion: < ¼ hemithorax opacified or <10 mm fluid on lateral decubitus

Moderate effusion: ¼ to ½ hemithorax opacified or 10-20 mm fluid on lateral decubitus

Large effusion: > ½ hemithorax opacified or >20 mm fluid on lateral decubitus

Respiratory Distress: Children with deficiencies in oxygenation and/or ventilation may have some evidence of respiratory compromise, as indicated by increased respiratory distress. Decreased work of breathing may be noted as the patient becomes fatigued and progresses toward respiratory failure and respiratory arrest.

Respiratory distress is assessed as part of the PEWS score and is classified as either none/minor (0 points) or moderate/severe (1 point). The following table provides general criteria for classifying work of breathing.

<table>
<thead>
<tr>
<th>None/Mild (0 points)</th>
<th>Moderate/Severe (1 point) (Any of the following)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• No retractions</td>
<td>• Retractions (scalene, subcostal or intercostals indrawing)</td>
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<tr>
<td>• Able to speak in complete sentences</td>
<td>• Speaks in phrases or words</td>
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<td></td>
<td>• Nasal flaring</td>
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<tr>
<td></td>
<td>• Grunting</td>
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</table>

The other respiratory aspects of the PEWs criteria (oxygen need and respiratory rate) are also important indicators of a child’s respiratory status.

EQUIPMENT

Monitoring equipment: pulse oximeter

Supplies for instilling tPA into pigtail catheter:

- 2 vials Cathflo® (tPA, alteplase) for a total of 4 mg
- 0.9% sodium chloride for injection vials (10 mL for children less than 1 year, 40 mL for children greater than 1 year)
- 10 mL syringe for children less that 1 year
- 60 mL syringe for children greater than 1 year
- Personal protective equipment (gown, gloves, mask with face shield or goggles)
PROTOCOL FOR THE MANAGEMENT OF PLEURAL EFFUSIONS IN PREVIOUSLY HEALTHY PEDIATRIC PATIENTS

PROTOCOL ALGORITHM

Child presents with pleural effusion on CXR

Clinical picture suggestive of infectious empyema? 1

Individualize management

Initial investigations 2

Start antibiotics 3

Small effusion
Less than ¼ hemithorax or Less than 10 mm on decubitus

Continue IV antibiotics and monitor for clinical response over next 48 hours

Moderate to large effusion
More than ¼ hemithorax or More than 10 mm on decubitus

Has effusion increased in size?

Yes

Consult Infectious Diseases, Respiratory Medicine
Ultrasound to assess size and loculations

No

Are any of the following present:
1) Complete white out with/without mediastinal shift?
2) Significant respiratory distress?
3) Sepsis?
4) ICU admission?

Observe and consider need for chest tube over next 48 hours 4

No

Yes

Ultrasound guided chest tube placement 5
Consult Surgery

Administer tPA 6

If no improvement

Continue IV antibiotics until discharge criteria are met 9

Remove Chest Tube when drainage less than 2 mL/kg/day

Failure to improve after 3 doses of tPA 8

Individualize management

Failure to improve after 3 doses of tPA 8

Chest Tube Management 7
• Suction at 15 cm H2O
• Flush q12h with 10 mL NS
EXPLANATION OF TERMS IN ALGORITHM

1. Clinical history
   - Suggestive of infection if initial cough and fever with elevated white cell count and CRP
   - Assess for tuberculosis risk factors (infectious contacts, travel to endemic areas),
   - If history not suggestive of infection consider other diagnosis such as malignancy, underlying rheumatologic disorder, chylothorax, cardiac or renal failure

2. Initial investigations
   - Blood work:
     - CBC + differential
     - Urea, creatinine and electrolytes (if abnormal, consider urinalysis to assess for hemolytic uremic syndrome)
     - Blood culture (including anaerobes)
     - Serum albumin
     - Antistreptolysin-a Titre (ASOT)
     - C-Reactive Protein (CRP), Erythrocyte sedimentation rate (ESR)
   - Nasopharyngeal wash for viruses, resplex
   - Sputum culture (if available)
   - Imaging
     - Chest X-Ray (2 views: PA and lateral decubitus with affected side down to assess if fluid is free flowing)
     - Chest ultrasound if moderate to large effusion (assess size of effusion and degree of loculation)
     - TB skin test if any clinical suspicion for tuberculosis

3. Choice of antibiotics
   - Empiric therapy with third generation cephalosporin (cefotaxime, ceftriaxone) and if an atypical infection is suspected, a macrolide
   - Addition of vancomycin only indicated if clinical suspicion of MRSA, resistant streptococcus pneumonia or patient is critically ill (in consultation with infectious disease service)
   - Step-down to pathogen specific antimicrobial therapy if organism isolated in blood or pleural cultures

4. Observe for 48 hours recording the following observations:
   - Vital signs include oxygen saturation at a minimum of every 4 hours
   - Pain score, arousal score, PEWS score every 4 hours or more often if clinically indicated
   - Accurate fluid balance
   - Systemic symptoms of energy, appetite
   - Respiratory Distress (none/minor versus moderate/severe, see definitions)
   - A persistence or increase in the following indicate poor response to treatment: respiratory distress and oxygen requirement, toxic appearance, poor oral intake, degree of effusion on radiograph, fever pattern

5. Ultrasound guided "pigtail" chest drain insertion
   - Discuss indications for chest tube placement with patient and family
   - NPO orders as per standard fasting guidelines: 2 hours clear fluids, 4 hours breast milk, 6 hours formula, non-human milk or light meal.
   - Perform coagulation studies (PT, PTT, INR, d-dimer, fibrinogen), CBC, electrolytes if not done in last 24 hours
   - Complete requisitions for analysis of the pleural fluid and send to the radiology department with the child
• Pleural fluid should be sent for:
  o Gram stain and bacterial culture
  o AFB smear and culture
  o Cell count and differential
  o Resplex
  o Consider cytology if clinical course not typical for empyema

6. Guidelines for administration of tPA (alteplase, CathfloS®)
• Contraindications for tPA
  o Anaphylaxis to previous tPA
  o Frank blood from chest tube

• Dosage and administration
  o Dilute 4 mg of tPA with 0.9% sodium chloride. Dilute with 10 mL for children below 1 year and 40 mL for children older than 1 year using the Parenteral Drug Manual as a guide for reconstitution and stability
  o Inject the tPA and NS mixture into the pleural space via the 3-way stopcock on the chest tube.
  o Flush with 10 mL NS
  o Clamp the chest tube / keep the stopcock closed for 1 hour to allow the tPA to dwell
  o For the hour while the tube is clamped, the patient is on bedrest and will be nursed 1:1 with vital signs plus work of breathing recorded every 15 minutes
  o UNCLAMP TUBE IMMEDIATELY IF THERE IS ANY OBJECTIVE DETERIORATION IN THE PATIENT’S RESPIRATORY STATUS
  o At 1 hour, unclamp the tube and initiate/resume suction at 15 cm H2O as per orders
  o Record heart rate, respiratory rate, oxygen saturation at 30 and 60 minutes post unclamping, and resume hourly recording of chest tube output
  o Contact the responsible resident if any concerns arise.
  o tPA can be repeated every 24 hours x 3 doses total
  o Nurse to document tPA doses given in MAR, and volume of tPA and normal saline flush in flowsheet

• Side effects of tPA
  o pain with instillation
  o transient blood staining of pleural fluid
  o frank blood in pleural fluid
  o anaphylaxis

7. Management of patients with pigtail chest tubes on the inpatient units
• Chest tube management
  o Chest tube should be connected to 15 cm of H2O of suction
  o Chest tube to be flushed every 12 hours with 10mL NS by physician (to prevent blockage), MD to record in progress note and nurse to document in MAR and on flowsheet
  o Nurse to notify physician if chest tube output diminishes acutely or if patient has increase in respiratory distress to assess chest tube patency (flush chest tube with 10cc of NS to assess chest tube patency)
  o Chest tube output to be recorded in flow sheet every hour

• Patient Monitoring
  o Patient to have continuous oxygen saturation monitoring
  o Record the following observations in the flowsheet: Vital signs, Respiratory distress, Pain score, PEWS score, Arousal score at a minimum of every 4 hours
• Ongoing investigations
  o Chest x-ray repeated
    ▪ 24 hours post chest tube insertion
    ▪ 1 hour post drain removal to exclude a pneumothorax
    ▪ If patient has increased respiratory distress (after chest tube has been flushed)
  o Bloodwork (CBC, electrolytes, CRP) to be repeated as clinically indicated and should be done
    if patient is not improving clinically or radiographically

8. Failure to improve after chest tube insertion and administration of tPA
• Discuss case with surgical team
• Repeat ultrasound should be done to reassess the fluid collection
• CT scan of thorax if required for pre-surgical assessment

9. Criteria for discharge from hospital
• Improvement in overall clinical appearance (level of activity, appetite), decrease in fever pattern for
  at least 24 hours
• Resolution of increased work of breathing and oxygen need
• Ability to tolerate oral medications
• Duration of oral antibiotics depends on extent of residual disease (typically a total duration of 2-4
  weeks of antibiotics is required)
• Outpatient follow-up with primary care physician in 1-2 weeks and with respirology clinic in 1-2
  months or as indicated

IMPORTANT DIFFERENCES FOR SURGICAL CHEST TUBES
If the child has undergone a surgical procedure a surgical chest tube may be placed instead of a
pigtail chest tube:
• A 4 mg dose of tPA may be administered on a case-by-case basis by the surgical team. This
dose will be flushed with NS 10 mL (20 Fr or smaller chest tube) or 20 mL (larger than 20 Fr
chest tube).
• Following the 1 hour dwell time the tube will be placed on suction via the chest tube drainage
system at a pressure of 10 cm water.
• Surgical tubes do not require every 12 hourly flushes of NS

DOCUMENTATION
Physician will document:
• Pre-drain insertion assessment and consent process
• Administration of tPA and flushes in progress notes including date, time, dose, volume
• Patient response to treatment

Registered Nurse will document:
• When tPA and flushes have been administered and by whom in the MAR
• Vital signs, pain score, arousal score, PEWS score respiratory distress on flowsheet/nurses notes
  (see Appendix A)
• Volume of flushes and tPA into chest tube, hourly and cumulative output from chest tube recorded
  hourly on flowsheet (see Appendix A)
• Site to source check of chest tube, drainage unit, and suction recorded on flowsheet (see Appendix
  A)
• Patient response to treatment
• Patient/family education
REFERENCES


### Appendix 1: Documentation needed for patients with chest tubes

<table>
<thead>
<tr>
<th>Respiratory Distress</th>
<th>Severe/Moderate: Significant retractions, Speaks in phrases/words, Grunting, Nasal flaring</th>
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<tbody>
<tr>
<td></td>
<td>Mild/None: Minimal retractions, Able to speak in sentences</td>
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</table>

### PEWS Flowchart

**Total PEWS**
- Total PEWS = Count number of entries in shaded boxes

**Septic Screen**
- Perform Septic Screen if PEWS score increases or if temperature is greater than 38.5°C or less than 36.9°C

**Infusions (drip/hr)**
- Pain score
- Tool/Scale Used
- Location of pain

**Pain (4th & 8th)**
- Vascular Access Site
- Infection Score
- Phlebitis Score
- Localized Pain
- Pain Score

**Hourly Checks**

**Routine Nursing Care**
- Repositioning
- Sleep (6) / Awake (A)
- Ambulation
- Intra-vein site care
- Foley Catheter care
- Perineum
- Shower (5) / Bath (B)
- Mouth care
- Ulcer dressings change
- Family presence
- School / Playroom

**Documentation if chest tube, drainage unit, suction is intact or if air leak is present**
## PROTOCOL FOR MANAGEMENT OF CHEST TUBES

### APPENDIX A: FLOWSHEET DOCUMENTATION

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<thead>
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<th>TIME:</th>
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</table>

### BODIES

- Less than 10 kg: 100 mL per kg | 4 mL per kg
- 10 – 20 kg: 1000 mL + 50 mL per kg | 2 mL per kg for each kg greater than 10
- Greater than 20 kg: 1600 mL + 20 mL per kg | 1 mL per kg for each kg

### OTHER MEASUREMENTS

- (height, temperature, weight, heart rate, respiration, etc.)
### PROTOCOL FOR MANAGEMENT OF CHEST TUBES

**APPENDIX A: FLOWSHEET DOCUMENTATION**

### Example #2

In the event that the atrium collection chamber tips over, and drainage falls into another chamber, consider the following...

<table>
<thead>
<tr>
<th>Time</th>
<th>05 06 07 08 09 10 11 12 13 14 15 16 17 18 19</th>
</tr>
</thead>
</table>

#### Intake

- **Unk** 85

#### Output

- **Chamber 1**
  - Level: 185, 187, 189, 190, 189, 192, 193, 195, 190, 192, 183, 198, 195, 198
- **Chamber 2**
  - Level: 10, 14, 21, 21, 44, 50, 50, 71, 79, 93, 80, 84

#### Cumulative Total In:

<table>
<thead>
<tr>
<th>Chamber</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>85</td>
</tr>
</tbody>
</table>

#### Cumulative Total Out:

<table>
<thead>
<tr>
<th>Chamber</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>186</td>
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</tbody>
</table>

#### Cumulative Total Out:

<table>
<thead>
<tr>
<th>Body Weight</th>
<th>Fluid Requirement per Day</th>
<th>Fluid Requirement per Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10 kg</td>
<td>100 mL per kg</td>
<td>4 mL per kg</td>
</tr>
<tr>
<td>10 - 20 kg</td>
<td>1000 mL - 20 mL per kg</td>
<td>2 mL per kg per kg - 10 kg</td>
</tr>
<tr>
<td>Greater than 20 kg</td>
<td>1500 mL - 20 mL per kg over 20 kg</td>
<td>1 mL per kg per kg - greater than 20 kg</td>
</tr>
</tbody>
</table>

### Other Measurements:

- People admitted (1): total 0
- People discharged (1): total 0

### Days on Unit:

- Admission weight:
- Previous 24hr weight:
- Today's weight: